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FOREIGN TECHNOLOGY DIVISION

THE PATH TO THE STARS. COLLECTION OF SCIENCE-FICTION WORKS

By

K. E. Tsiolkovsky

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EDITED MACHINE TRANSLATION

THE PATH TO THE STARS. COLLECTION OF SCIENCE-FICTION WORKS.

By. K. E. Tsiolkovsky

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K. E. Tsiolkovskiy

PUT' K ZVEZDAM

Sbornik
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ABOUT THE COLLECTION OF SCIENCE-FICTION WORKS

K. E. Tsiolkovsky

If one were to talk in generality, the content of collection of science-fiction works of K. E. Tsiolkovsky are quite interesting and even amusing. These works evoke great interest, force one to reflect on many purely concrete problems imposed by navigation in outer space, and will contribute to the increase of number of enthusiasts in this region of science and technology. Such compositions as "On the Moon," "Beyond the Earth" and others are read with interest and leave a deep imprint on the memory of the reader.

In the collection there is reflected outlook of K. E. Tsiolkovsky, eccentric thinker, self-taught scientist, fundamental originator and great enthusiast of outer navigation. He strove to substantiate in his works the idea that man, being completely bound to his native planet, would nevertheless gain infinitely if he gradually would conquer outer space. He proved that life in outer space, where there is no acceleration due to gravity with respect to inhabited location of the rocket, or even on such bodies as the Moon or asteroids, where the gravity is extraordinarily small as compared to the Earth, has great advantage inasmuch as here with the same expenditure of energy it will be possible to produce incomparably greater work. Furthermore, in the absence of any pathogenic microbes, using the continuous radiation of the Sun in artificially created locations with regulated temperature, humidity and composition of air, it would be possible to cultivate various plants,

supplying food products for the human population and, on the other hand, absorbing the excrations of animal organisms.

The realization of similar equilibrium animal and vegetable life on large space rockets, equilibrium, allowing indefinitely long existence in outer space during conditions, of only regulated consumption of energy of solar rays, presents a very interesting idea which one should consider in detail for the possibility of its realization.

It is possible to agree also with the author's idea about the fact that life will be excellently developed and will flourish also with the absence of gravity and that for animal organisms the atmospheric pressure may be much lower than the usual Earth-normal. K. E. Tsiolkovsky's considerations about various devices ensuring the convenience of existence inside the rocket in the absence of gravity are very interesting.

Very captivating are his description of lunar landscapes, journeys to the Moon and even his fantasy about the jumping lunar animals or animalplants, which hide in ravines or follow the sun in order to escape the approaching cold of the lunar night. Even these fantasies seem appropriate, since in spite of their improbability they soften the picture of the severe situation of nature in the Moon.

However, K. E. Tsiolkovsky dreams excessively when he turns to the description of imaginary life of intellectual creatures on all possible planets — Mercury, Mars, asteroids and so forth. Therefore, such compositions or extracts as "Living creatures in Space," "On Vesta," "Mercury," "Mars," "Asteroids" and certain others, are unadulterated fantasy and those which discuss the thinking creatures on these planets and asteroids are not cognitive material. To such works also pertains "Ether Island" — regarding the forming and evolution of the Universe. The author assumes, in accordance with the opinions of physicists of the 19th century, that there exists a "luminiferous ether," which, according to his assumption, does not reach far beyond the limits of the physical Universe, accessible to us. Thus, in the authors opinion, our system of galaxies is considered to be hopelessly

isolated from other analogous systems, since in the absence of another medium between them transmitting propagation of light, there is no possibility of observing the other systems. Similar arbitrary affirmations — this should be underlined, — absolutely do not harmonize with all of the Weltanschauung of Tsiolkovsky, which knows no barriers in the knowledge of infinite universe.

However, even in acceptable works of Tsiolkovsky from scientific point of view there are a number of errors which one should note.

First of all, the author does not consider sufficiently the fact that also during weakening of gravity force there remains the same inert mass, for the communication to which of a known acceleration the same force is required as in terrestrial conditions. Further, the possibility of protection of living creatures from excessive acceleration, appearing, for instance, during acceleration of rocket, by means of submersion of this living creature into a closed vessel with water, is overrated. It is true, as Tsiolkovsky indicates sharp blows on the shell of a similar vessel are almost not transmitted to the organism locked inside. But sharp braking or acceleration of the complete vessel on the whole turns out to be sufficiently felt and can even be destructive. Author absolutely does not consider the danger from collisions with meteorites. Curious and peculiar to K. E. Tsiolkovsky's humor is the description of the possible catching of meteors, approaching the spaceship, with the help of a net similar to that for catching butterflies. In reality each hit of any of the numerous micrometeorites produces a small explosion and, as result creates a dent on the shell of the spaceship. Similar hits, which should occur very frequently, almost instantly will destroy the external greenhouse designed by the author, which is protected only by thin glass from the surrounding outer space. Even at a great distance from the Earth, when the acceleration of meteorite by terrestrial attraction will be almost absent, the relative speed of encounter with the spaceship, will be nevertheless, kilometers and even tens of kilometers per second. With significant mass of meteorites this will present a significant threat for safety of the spaceship.

Certain factors in separate works of Tsiolkovsky sometimes receive inaccurate evaluation. For instance, several times facts indicate that temperature of heating in focus of mirrors, condensing the solar rays, at known luminosity reaches up to 6,000°. Similar temperature of heating can be purely theoretically comprehended only in that case when the angular dimensions of the Sun are increased by mirrors to dimensions of full sphere; this is practically impossible.

In accordance with the concept of that period, when the present works were written, Tsiolkovsky indicates that each star is surrounded by a family of planets, and all these planets are inhabited, independent of their temperatures and remaining physical conditions. In his opinion which however, is repeatedly declared also by other authors, the living organism may be composed of any elements which at given temperature can give liquid compounds. Here we do not even find a reminder about the unique role for the construction of living organism of compounds of carbon with oxygen, hydrogen, and also with nitrogen, which require absolutely specific and strictly limited conditions. The existence of any kind of an atmosphere K. E. Tsiolkovsky also did not consider as a necessary condition for the existence of organic life, assuming that organisms can produce and get along with their own internal atmospheres. There is no need to indicate the complete fantasy of such concepts.

Ardent propaganda of the conquest of outer space is the great service of K. E. Tsiolkovsky. But his fantasy in this respect knows no limits. He wants to emphasize that migration of humanity to other planets near some other sun will become a necessity, when our own Sun will start to cool signficiantly and this, in his opinion, can happen already in several million years. Naturally, in the times of Tsiolkovsky the only source supporting solar radiation was considered the gravitational energy of compression. However, at present it is impossible to think of cooling of the Sun in a strict sense of this word — it can in the end cross into the class of white dwarf stars, extraordinarily condensed, with ~~insignificant~~ radiation but with high internal temperature. Such a process will demand, at least,

several billions and not millions, of years. In different works he expresses the thought that population of the innumerable planetary systems, found in various regions of the Universe would, to negate the danger arising from the "superannuation" of their suns, organize certain type of associations or unions of mutual assistance for cooperation in migrations to the most suitable planets. Thereby, the fantasy of the author already reaches to extreme limits.

Life in Space nevertheless in reality should be considered as a rare exception and not the general rule. But this does not at all reduce the great scientific and practical significance of K. E. Tsiolkovsky's ideas of adjusting to outer space, at whose threshold we now stand, as a result of the great accomplishments of Soviet science and technology, which founded the beginning of a new era in the history of mankind.

The mastering of Space occurs namely in the same directions that for many decades were already shown by Tsiolkovsky with extraordinary perspicacity. Tsiolkovsky was definitely an exceptional personality, and all pertaining to him presents significant interest. Therefore, although many of his expressions cannot be accepted at present, nonetheless all this can serve as best evidence that Tsiolkovsky was not only a designer of rocket motors, but in his dreams, in his science-fiction works, had already begun to live in Space.

Academician V. G. Fesenkov

Moscow. October 1960.

ON THE MOON

Fiction Tale

I

I awoke and, still lying in bed, pondered only on what I had seen in my dream. I saw myself bathing, and since it was winter, I particularly enjoyed dreaming about summer bathing.

Time to arise!

I stretch, arise... How easy! Easy to sit, easy to stand. What is this? Is the dream continuing ? I feel that I stand especially easily, as if immersed to the neck in water, my feet barely touch the floor.

But where is the water? Can't see it. I wave my hands, I do not experience any resistance.

Am I asleep? I rub my eyes — still the same.

Strange!

However, I have to dress!

I move chairs, open cabinets, set my clothing, pick up various things and — can't understand anything!

Perhaps my strength has increased?.. Why has everything become so light? Why can I lift such objects, which before I could not move?

No! These are not my legs, not my hands, not my body!

Those others are so heavy and do everything with such effort...

From where comes the power in my hands and legs?.

Or perhaps some force pulls me and all objects upwards and facilitates my work? But, in such a case, how strongly it pulls! A little more — and it seems to me, I will be carried away to the ceiling.

Why don't I walk but jump? Something pulls me to the side, contrary to weight, strains the muscles, forces to make a jump.

I cannot oppose temptation — I jump...

It appeared to me that I was lifted slowly enough and descended just as slowly.

I jump faster and from a respectable height examine the room... Oh! — I hit my head against the ceiling... The rooms are high... I did not expect a collision... I won't be so careless anymore.

The scream, however, awakened my friend: I see, how he turned and after a moment jumped out of bed. I will not begin to describe his as' ishment, similar to mine. I saw the same spectacle that I inconspicuously, several minutes ago, presented. I derive great pleasure from watching the bulged eyes, comical poses and unnatural liveliness of motions of my friend, I was amused by his strange exclamations, very similar to mine.

Permitting the reserve of surprise of my physicist friend to be exhausted, I turned to him with the request to solve for me this question: what happened — is our strength increased or is the weight decreased?

Either assumption is equally amazing, but there is nothing, on which man, becoming accustomed to it, would not begin to look indifferently. We did not reach this point, but we have already begun to have a desire to find the reason for all this.

My friend, accustomed to analysis, quickly sorted out the mass the phenomena, stunning and confusing my mind.

— By dynamometer, or by spring scales, — he said, — we can measure our muscular strength and find out whether it has increased or not. Here, I rest by legs on the wall and pull the lower hook of the dynamometer. See — five poods;

my strength has not increased. You can perform the same and also to be convinced that you did not become a hero like Il'ya Muromets.

— It is different to agree with you, — objected I: — the facts contradict. Explain to me, how can I lift the edge of this book cabinet, which weighs less than fifty poods? At first I imagined that it was empty, but, upon opening it, I saw that not a book had vanished... Explain, incidentally, also the jump to a five-arshine* height!

— You lift large loads, jump high and feel self light not because you have more strength — this assumption is already refuted by the dynamometer, — but because weight has decreased, in which you can also be convinced by means of the same spring scales. We will even find out, precisely how much it has decreased...

With these words he lifted the first weight at hand, called the 12 pounder, and attached it to the dynaometer.

— Look! — he continued, glancing on the indication on the scales. — the 12 pound weight turns out to be in two pounds. This means that the weight decreased by six times.

After thinking he added:

— Precisely the same graviation exists also on the surface of the Moon, owing to its small volume and the low density of its substance.

— Could we be on the Moon? — I burst out in laughter.

— Even if we are on Moon, — laughed the physicist, getting into the humorous mood, — the trouble is not great in that, since such a miracle, once it is possible, can be repeated in reverse order, that is, we will again return home.

— Halt, enough of this joshing... And what if one were to weigh any object on ordinary scales! Would the decrease of weight be noticeable?

— No, because the weighed object decreases in weight in as many times, as the weight placed on other cup of the scales, so that the equilibruim is not disturbed,

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* An arshine is a unit of length equal to 28 inches [Translation Editor].

in spite of the change of weight.

— Yes, I understand!

Nonstheless, I will still try to break the stick — in expectation to find addition of strength, which incidently I did not manage, although the stick is not thick and only yesterday crackled in my hands.

— Such an obstinate person.! Leave it alone! — said my physicist friend, — Think better about the fact that now, probably, the world is agitated by changes...

— You are right, — I answered, throwing aside the stick, — I forgot all, forgot about the existence of humanity, with which I just as you want desperately to share by thoughts...

— What happened to our friends?.. Were there other revolutions?

I already opened my mouth and jerked open the curtain (they all were lowered for the night from moonlight, disturbing our sleep,) to exchange words with the neighbor, but immediately hastily retreated. Oh, horror. The sky was blacker than the blacked-ink.

Where is the city? Where are the people?

Some sort of wild, inconceivable, brightly illuminated by sun site!

Were we not really transferred to some desert planet?

All this I only thought — I couldn't say anything and only muttered incoherently.

My friend rushed to me, assuming that I felt badly, but I indicated to the window, and he rushed there and also became dumbfounded.

If we did not fall into a faint, it is only due to small weight, preventing unnecessary influx of blood to the heart.

We looked back.

Windows were as before curtained — that which surprised us was not before our eyes; the ordinary view of the room and familiar objects located in it made us still calmer.

Pressing together with a certain timidity we, at first, lifted up only the edge of the curtain, then we drew all the curtains and, finally, we decided to emerge from the house for observation of the morning sky and environment.

In spite of the fact that our thoughts were absorbed with the forthcoming jaunt, we still noticed some things. Thus, when we walked in large and high rooms, we had to act with our hardened muscles extremely carefully — otherwise the sole slipped on the floor uselessly which, however, did not threaten a fall, as this could be on wet snow or on the earth's ice; here the body jerked significantly. When we wanted to get into a horizontal position rapidly, then in the first moment it was necessary to noticeably lean forward, similar to the way a horse leans forward, where it is forced to shift a cart with back-breaking load, but this only appeared so — in actuality all our motions were extremely easy... To descend the stairs step by step — how dull this is! Motion by step — how slow is this! Soon we abandoned all these ceremonies, useful on the Earth but comical here. We learned to gallop forward, we descended and rose by ten steps and more, as most desperate students, or else at other times we jumped directly over the whole stairs or from the window. In one word, the force of circumstance turned us into leaping animals, like grasshoppers or frogs.

Thus, after running around in the house, we jumped outside and ran galloping in the direction of one of the nearest mountains.

Sun was dazzling and seemed dark-bluish. Screening the eyes with our hands from the Sun and the environment shining from reflected light. It was possible to see the stars and planets, which were also for the most part dark-bluish. Neither these nor the others "winked," which made them seem like nails with silver heads hammered into black dome.

And, here is the Moon — the last quarter! Well, it could not surprise us, since its diameter seemed three or four times larger than the diameter of the Moon seen by us before. And also it shone brighter than by day on Earth, when it is

presented in the form of white small cloud... Stillness... clear weather... a cloudless sky... One cannot see either plants nor animals... The desert with a black monotonous dome and with blue Sun-corpse. Not a lake, not a river and not a drop of water! If only the horizon were whitened — this would indicate presence of vapors, but it is the same black, as also the zenith!

There is no wind which rustles in the grass and sways the summits of trees on Earth... The chirping of grasshoppers is not audible... Neither birds nor colorful butterflies are visible! Only mountains and mountains, terrible, high mountains, summits of which, however, do not shine with snow. Not a snowflake anywhere! Away with valleys, plains, plateau... How many stones are piled up there... black and white ones, large and small ones, but all sharp, shining, not rounded, not softened by waves which here there have never been, which did not play with them with gay noise, did not work on them!

And here is a place which is quite smooth, although wavy: one cannot see a single stone, only black cracks stretched to all sides, like snakes... Hard soil — stone like... There is no soft chernozem, there is neither sand nor clay.

It is a gloomy picture! Even the mountains are bared, shamelessly uncovered, since we do not see on them the light veil of transparent, dark-bluish haze which the air throws over the terrestrial mountains and distant objects... Severe, surprisingly distinct landscapes. And the shade! Oh, what dark shade! And what sharp transitions from gloom to light! There are none of those soft overflows to which we became so accustomed and which only atmosphere can give. Even the Sahara would appear a paradise in comparison with that which we saw here. We wished for its scorpions, its locusts, for the heated sand raised by dry wind, not to mention the seldom encountered scanty vegetation and date groves... It was necessary to think about our return. The soil was cold and one felt the cold, so that the legs shivered, but the Sun kept scorching. In general one felt the unpleasant sensation of cold. It was like a frozen man trying to get in before a blazing fireplace

and unable to get warm because it is excessively cold in the room; on his skin pass pleasant sensations of heat, which are not capable of overcoming the chill.

On the return way we warmed up by jumping with the ease of a chamois over two-sagene* stone heaps... There were granite, porphyrys, syenite, rock crystals and various transparent and opaque quartzes and silica — all of volcanic origin. Later, indeed, we noted traces of volcanic activity.

Here we are at home!

In the room you feel well: the temperature is uniform. This disposed us to proceed to the new experiments and the discussion of all that we had seen and noticed. It is clear that we are on some other planet. On this planet there is no air, no other atmosphere.

If there were gas then the stars would blink; if there were air, the sky would be blue and there would be haze on the distant mountains. But how do we breathe and hear one another? This we did not understand. From a great number of phenomena it was possible to note the absence of air and any kind of gas. Thus, we could not manage to smoke a cigar, and rashly we spoiled a lot of matches; a closed and impenetrable rubber bag was compressed without the least effort, which would not have been had there been any gas in its volume. This absence of gases scientists have proven also on the moon.

— Could we be on the Moon?

— Did you notice that from here the Sun does not seem any larger nor smaller than from the Earth? Such a phenomenon could be observed only from the Earth and from its satellite, because these celestrial bodies are almost at an equal distance from the Sun. From other planets it should seem either larger or smaller; thus from Jupiter the angle of the Sun is five times less, from Mars — about one and a half times, and from Venus to the contrary, — one and a half times greater: on Venus the Sun burns twice stronger, and on Mars — twice weaker. And what a

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* A sagene is unit of length equal to about seven feet. [Translation Editor].

difference in two planets closest to Earth. On Jupiter, however, for instance, the Sun heats twenty-five times less than on Earth. Nothing similar to that do we see here, in spite of the fact that we have absolute possibility to do so due to the supply of goniometrical and other measuring instruments.

— Yes, we are on the Moon; Everything indicates that.

— The dimensions of the "moon" which we saw in form of a cloud and which is apparently the planet which we abondoned not involuntarily point to the fact that we are on the Moon. It is a pity that we cannot now view its spots, its portrait and determine finally the place of our location. We will await the night...

— What you do mean, — I noted to my friend, — that the Earth and Moon are at an equal distance from the Sun? Personally, I believe the distance is quite respectable. After all it is, as well as I know, equal to three hundred sixty thousand versts.

— I say, almost, because these three hundred sixty thousand are only one four hundredths part of the total distance to the Sun, — objected the physicist. — It is possible to disregard one four hundredth.

II

How tired I am, and not so physically as mentally. I want to sleep frightfully... What time is it?.. We arose at six, now it is five... eleven hours have passed, meanwhile; judging by the shadows the Sun has hardly moved. There is the shadow from the steep mountain which did not quite reach the house, and now still falls short by the same distance; here is the shadow from the weather vane, resting on the same stone...

This is yet another new evidence that we are on the Moon...

Its rotation around the axis is so slow... Here the day should continue for around fifteen of our days, or three hundred sixty hours, and as many — for the night. It is not quite convenient... The Sun hinders sleep! I recall that I experienced the same when I happened to live for several summer weeks in the polar countries. The Sun did not drop below the horizon and it was quite boring!

However, there is a great difference between then and now. Here the Sun moves slowly, but in the same order, there it moves rapidly and each twenty four hours, low above the horizon it draws a circle...

And there and here it is possible to use the same method, closing the shutters..

However, is the timepiece correct? Why such a dissention between the pocket watch and the wall clock with the pendulum? On the first — it is five o'clock, and on wall clock — only 10 A.M... Which ones are correct? Why does this pendulum swing so lazily?

Apparently, this clock is slow!

However, the pocket watch cannot lie, since its pendulum sways not by weight, rather from the elasticity of the steel spring, which is still the same — as on Earth, so also on the Moon.

We can check this by taking the pulse. I had seventy strokes per minute... Now seventy five... A little more, but this can be explained as from nervous excitation, depending on extraordinary situation and strong impressions.

However, there is still a possibility to check the time: at night we will see the Earth, which rotates every twenty four hours. This is the best and infallible timepiece!

In spite of the drowsiness conquering us both, my physicist did not refrain from correcting the wall clock. I see, how he removes the long pendulum, measures it exactly and shortens it by six times or about six times. The venerable timepiece starts ticking. But here they are no longer ticking, because also the short pendulum conducts itself exponentially, although not as the long one. Due to this metamorphosis the wall clock was made to agree with the pocket watch.

Finally we lie down and cover ourselves with light weight blankets, which seem here as though they are made of air.

Pillows and mattresses are almost not used. Here it is possible, it seems, to sleep even on boards.

I cannot free myself from the thought that it is still too early to go to sleep. Oh, this Sun, this time! You freeze like the whole lunar nature!

My comrade ceased to respond; I too fell asleep.

A gay awakening... Cheerfulness and wolfish appetite... Till now the excitement deprived us for the ordinary urge for food.

I want to drink! I pull open the cork... What is this — the water boils. Slowly, but it boils. I reach for the decanter. Careful not to be burned....... No, the water is only warm. It is unpleasant to drink such water!

— My physicist, what will you say to this?

— Here there is air absolute vacuum, that is why the water boils; it is not held by the pressure of the atmosphere. Let it boil for a while, do not shut the cork. In a vacuum boiling is terminated by freezing... But we will not bring it to a freezing point... That is enough! Pour water into the glass, and plug the cork, otherwise too much will evaporate.

On the Moon liquid pours slowly!..

The water in the decanter calmed down, but in the glass continues to be agitated lifelessly — and the longer, the weaker.

The remainder of water in the glass turned into ice, but even the ice evaporates and decreases into mass.

How will we dine now?

Bread and other more or less hard food could be eaten freely, although they dried out rapidly in an unclosed hermetic box; bread turned into stone, fruits shriveled up and also became considerably hard. However, their thin skin still retained moisture.

— Oh, this habit to eat hot food! What are we going to do with it? After all, here it is impossible to start a fire: neither wood nor coal nor even a match would burn!

— Couldn't we use the Sun in this matter?.. One bakes eggs on the heated sands of the Sahara!......

Pots, and saucepan, and other vessels we altered in such a manner so that their covers would fit tightly and so that they would be fastened strongly. Everything was filled with what it was supposed to be filled according to culinary rules, and all this was placed in a pile on a place covered by the Sun. Then we gathered all the mirrors located in the house and placed them in such a way that sunlight reflected from them fell on the pots and saucepans.

There hardly passed an hour, until we could eat already a well cooked and fried supper.

What is there to say!.. Have you heard about musho ?* His improved solar concoction was far behind times!.. Boastings, braggings? As you will... You can ascribe these presumptuous words to our wolfish appetites to which any rubbish would appeal.

One thing was bad; it was necessary to hurry. I will confess, we choked and gagged more than once. This will become understandable, if I will explain that the soup boiled and cooled off not only in the plates, but even in our throats, esophagi, and stomachs; should you slightly gape — look, instead of soup there is a piece of ice...

It is surprising, that our stomachs are still whole. The vapor pressure in good order stretched them, nevertheless...

In any event, we were satisfied and sufficiently quieted down. We do not understand how we live without air, how we ourselves, our house, yard, garden and reserves of food and drinks in the cellars and storage houses were transferred from the Earth to the Moon. Doubt descended upon us. And we thought, are we asleep, is this a devilish delusion? And after that we became accustomed to our position and viewed it partly with curiosity, partly indifferently; the inexplicable did not surprise us, and danger of dying from hunger alone and miserable did not even occur to us.

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* Author of science-fiction stories on astronomy of the past century, writing in the nineties. — Edit.

How could such impossible optimism be explained? This you will learn from the outcome of our adventures.

For a walk after food... I hesitate to sleep, I am afraid of a blow.

I entertain my friend.

We — are in a large yard, in center of which is raised a gymnastics, and on the edges — a fence and out-buildings.

Why is there a stone here? One can get hurt by it. In the yard the soil is ordinary terrestrial, soft. Away with it, over the fence!.. Be bold! Do not be afraid of the magnitude! And here a stone of about sixty poods with united force is lifted and is thrown over the fence. We heard, as it struck deafly against the stone soil of the Moon. The sound reached us not through the air, but underground; the blow brought tremor to the soil, then our body and the aural bones. In such a way we could frequently hear blows producible by us.

— Isn't this how we hear one another?

— Hardly! The sound would not resound as in air.

The lightness of motions evokes the strongest desire to climb and to jump.

Sweet time of childhood! I remember, how I climbed on roofs and trees, mimicking cats and birds. This was pleasant...

And the competetive jumps over ropes and ditches! And running for prizes! To this I was passionately devoted...

Shouldn't we remember the past? I had little strength, especially in my hands. I jumped and ran well, but climbed ropes and post poorly.

I dreamed about great physical strength: I would revenge my enemies and would award my friends!.. A baby and a savage — they are the same. Now these dreams about strong muscles to me are comical... Nonetheless, my desires, passionate in childhood, here came true. My strength, thanks to the insignificant lunar weight, was as if increased by six.

Furthermore, it is necessary for me now to conquer the weight of my own body, which still more increases the effects of strength. What does it mean to me that

there is a fence? Not more than a threshold or a stool which on Earth I can overstep. And so, as though to check this thought, we soar and without running, pass over the barrier. Here we jump and even jump over the shed, but for it, it was necessary to gather momentum. And how pleasant it was to run, you do not feel your legs. Let's... Who will overtake the other? Let's gallop!..

With each blow of the heel against the soil we flew over sagenes, especially so in the horizontal direction. Halt! In a moment — the whole yard, 500 sagenes — the speed of a racing horse*...

Your "gigantic steps" cannot make such jumps!

We made measurements, during comparatively light gallop, we rose four arshins above the soil, in longitudinal direction we flew five and more sagenes, depending upon the speed of the race.

— To gymnastics!..

Hardly straining the muscles, even for laughter, with the help of only the left hand we climbed the rope to the gymnastics area.

It is frightening; four sagenes to the ground!.. It seems all the time that I am on clumsy Earth!.. The head spins...

With a sinking heart I first decided to jump down. I am flying... Oh! I bruised my heel slightly!

I should have warned my friend about this, but I insidiously incited him to jump. Lifting my head, I shout to him:

— Jump, its alright — you will not be injured!

— You persuade me in vain! I know perfectly well that a jump from here is equal to a jump on Earth from a two-arshin altitude. It is understandable, that ~~my~~ heels will suffer somewhat!

My friend is also flying. A slow flight... especially at first. It was in all about five seconds.

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* The speed is somewhat exaggerated. — Edit.

In such an interval one can think of many things.

— Well what, physicist?

— The heart is beating — that's all.

— Into the garden!.. To climb trees, to run in the lanes!..

— Why didn't the leaves dry there?

Fresh greens... Protection from the Sun... High lindens and birch trees! Like squirrels we jumped and climbed on narrow branches and they did not break. Of course — after all here we are not heavier than fat turkeys!..

We slipped above shrubs and between trees, and our motion reminded us of flying. Oh, this was fun! How easy it is here to observe equilibrium! I trip on a twig, am ready to fall, but the inclination to fall is so small and the actual tilting from equilibrium is so slow that the least motion by hand or leg is sufficient to restore it.

To free space!.. The huge yard and garden seem like a cage... At first we run over an even surface. We encounter shallow ditches, ten sagenes in width.

From a running position we fly over them like birds. But here is an upgrade. At first a weak one, and then steeper and steeper. How steep! I fear shortness of breath.

A senseless fear. We rise freely, with big, fast steps on the slope. The mountain is high — and the light Moon fatigues [us]. We sit down. Why is it so soft here? Did the stones become softened?

I take a big stone and strike it against the other. Sparks fly.

We rested. To return...

— How far to the house?

— Now not too far, about two hundred sagenes...

— Can we throw a stone to this distance?

— I do not know, I will try!

We took a small angular stone... Who will throw further?

My stone flew over the dwelling. Excellently. Watching its flight I feared that it would break a window.

— And yours?.. Yours is still further!

Shooting should be interesting here. Bullets and cannon balls would fly in horizontal and vertical direction for hundreds of versts.

— But will the gun powder work here?

— Explosives in vacuum should manifest an even larger force than in air, since the latter only prevents their expansion. However, regarding, oxygen, one is not in need of it, because all of it that is necessary is already in them.

III

We came home.

— I will pour the powder on the window sill, illuminated by the sun, — I said, — Focus on it the igniting glass... See — fire... an explosion, although a noiseless one. — A familiar odor which disappeared instantly...

— You can shoot. Only do not forget to put on the piston. The igniting glass and the Sun replace the blow of the hammer.

— We will place the gun vertically, so that we can find the bullet close by after the explosion...

Fire, a weak sound, light shaking of the ground.

— Where is the wad? — I exclaimed. — It should be here, near by, even though it will not smoke!

— The wad flew together with the bullet and hardly lags behind it, because on Earth only the atmosphere prevents it from reaching as far as the lead. Here, however, also drops down and flies upwards with the same swiftness, as the stone..... Take the fluff, for instance, protruding from the pillow and I will take a cast-iron ball. You can throw yours down and hit the target, even at a distance, with the same convenience, as I can with the ball. I can, with this weight, throw the

ball about two hundred sagenes. You can cast the fluff onto the same distance. Naturally, you won't kill anyone and while throwing you won't even feel that you are throwing anything. We will cast our launching missiles with all our might, (which in our case is not very different), toward one target. Here, into that red granite...

We will see how the fluff will lead somewhat the cast-iron ball, as if attracted by a strong whirlwind...

— But what is this, from the time of the shot there passed three minutes, but the bullet is not apparent? — I said.

— Wait two minutes, and it will surely, return, — responded the physicist.

Truly, at the indicated approximate time we sense the light tremor of the ground and see jumping not far off the wad.

— Where is the bullet? After all it isn't the tuft of oakum that produced the tremor? — I exclaimed.

— Probably, from the blow the bullet heated to melting paint, and disintegrated into small particles to all directions.

After searching around, we actually found several very small pellets, being, obviously, particles from the lost bullet.

How long did the bullet fly!.. To what altitude would it rise? — I asked.

— To about seventy versts. This altitude is reached with small weight and absence of air resistance.

....

The mind and the body were fatigued and demanded rest. Even on the Moon, excessive jumps make themselves felt. Due to the duration of the flights, while performing there we did not always fall on our legs and thus were injured. In four to six seconds of flight it is possible to not only inspect the environment from a respectable altitude, but also to accomplish certain motions with the hands and legs; however, we did not achieve controlled tumbling in space. Later we

learned to impart to ourselves forward and circular motion simultaneously. In such cases we turned in space up to three times. It is interesting to experience this motion, and also interesting to observe it from the side lines. Thus, I watched at length the motions of many experiments of my friend the physicist, who accomplished them without support, without ground under his feet. To describe them would take a whole book.

....

We slept about eight hours.

It became warmer. The Sun rose higher above and heated even less, heating a smaller surface of the body, but the ground was warmed and the cold no longer overwhelmed us. In general, the effect of the Sun and ground was warm, almost hot.

It was time however, to take measure of precaution, since it became clear to us that prior to the approach of noon we could be "fried."

What should we do?

We had various plans.

— It is possible to live in cellar for several days, but it is impossible to predict that in the evening, that is after two hundred and fifty hours, the heat would not penetrate there, since the cellar is sufficiently deep. Furthermore, we would be lonesome without any conveniences and in closed space.

We will admit, that it is easier to ensure boredom and inconvenience than to be "fried."

But is not best to select a deeper ravine? Let's climb up there and spend the remainder of the day and part of the night there in the coolness.

This much more fun and more poetic. Or else — burial!.. That a man should be penned in such a place!..

And thus, the ravine. The stronger the Sun will shine, the lower we will descend. However, the depth of several sagenes is sufficient.

We will take umbrellas, provisions in tightly closed boxes and barrels. Over our shoulders we will throw fur coats, which could prove useful both during excessive

heat and during excessive cold. Besides here they will not burden the shoulders.

Still several hours passed by, in the course of which we managed to eat, to rest, and to talk about gymnastics on the Moon and about what miracles terrestrial acrobats could produce here.

To procrastinate any more was impossible. The temperature was infernal. At least outside, where in illuminated places, the stone soil was incandescent to a point where it was necessary to fasten comparatively thick small wooden boards under the boots.

Since we were in a hurry we dropped glass and clay dishes, but they did not smash — so light was their weight.

I almost forgot to relate the fate of our horse, launched here together with us. This unfortunate animal, when we wanted to harness him to a cart, somehow escaped from us and at first dashed faster than the wind, tumbling and getting injured. Then not realizing the strength of inertia and not succeeding in circling around a stone chunk in the path, he was smashed to smithereens. The meat and blood first froze, and then dried up.

One should mention also about flies. They could not fly, and only jumped, at least half an arshin...

....

And thus, taking up everything necessary and with a huge load on the shoulders, which did not amuse us, since everything seemed empty and thin which we packed. Closing the door, windows, and shutters at home, so that the house would not be heated as much and wouldn't be damaged by high temperature, we departed to look for a suitable ravine or cave.

During the search we were surprised by the sharp changes of temperature. Places, long ago illuminated by the Sun were scalding as from heated furnace. We tried to pass there faster and freshened up and rested anywhere in the shade, created by large stones or cliffs, — and refreshed to such a point that if we lagged any

longer, we could have made use of the fur coat. However, even these places in general, are unreliable; the Sun would turn to other side and illuminate the place where there were shadows and cold. We knew this and looked for a ravine where although the Sun would shine it would be only for a short time, would not heat the stones.

And here is ravine with almost vertical walls. One can see only the beginning of the walls — the ravine is black and seems bottomless. We passed the gorge and found there a sloping descent, leading, apparently, directly to hell itself. Several steps we made safely, but there it became darker, and one could not see ahead. To go further seemed horrible, and even risky... We remembered that we took with us an electric lamp, candles, and torches here were impossible... The light shone and instantly illuminated a ravine about twenty sagenes deep, the descent turned out to be easy.

Here is the fathomless ravine, here is hell! We were disillusioned the familiar barrenness.

It's darkness, in the first place is explained by the fact that it is located in shade and due to its narrowness and depth the rays from illuminated regions and high mountains do not penetrate there, and in the second place, because it is not illuminated from above by the atmosphere, as would be the case on Earth; therefore it would be impossible to encounter such severe darkness anywhere else.

As we were descending, grabbing on to the walls, sometimes the temperature dropped, but not lower than 15 degrees Celsius. Apparently, this is average temperature at that latitude... We selected a convenient level place, spread our fur coats and settled down comfortably.

But what is this? Is it night already? Covering the lamp with our hands, we see a swatch of dark sky and the many stars, glittering very brightly above our heads.

However, the chronometer shows that not much time has passed, and the Sun could not suddenly disappear.

Oh! An awkward motion — and the lamp is smashed, although the carbon ribbon continues to gleam even stronger. Had this been on Earth, it now would be extinguished, after burning in air.

With curiosity I touch it. It breaks — and everything is dipped in gloom. We do not see one another, only on top of the edge of the ravine we are slightly noticeable. And the long and narrow band of the black dome is lighted by a still greater amount of stars.

I cannot believe that day has reached its climax. I cannot wait any longer; with difficulty I find the reserve lamp turn on the electrical current and go upward... It is lighter and warmer... The light blinded me, the electrical lamps appears to have expired.

Yes, it is daytime, and the Sun and the shade on all the same place.

It's hot! Let's hurry back.

IV

From having nothing to do we slept like marmots. Our burrow was not being heated.

Sometimes we emerged from the burrow, looked for a shady place and observed the flow of the Sun, the stars, planets, and our large Moon which, in comparative magnitude with your pitiful Moon, was like an apple compared to a cherry.

The Sun moved almost at the same level with the stars and lagged hardly noticeable behind them, as can be seen from the Earth.

The Moon was absolutely motionlessly and was not seen from the ravine. We were sorry about that, since in the darkness we could have observed it with the same success as at night which was still far away. Unfortunately, we did not select another ravine, from which it would have been possible to see the Moon. But now it is too late!..

The noon hour was approaching, the shade ceased to be smaller. The Moon looked like a narrow sickle, getting paler and paler as it got closer to the Sun.

Moon — apple, Sun — cherry; if the cherry did not hide behind the apple, we would not have had a solar eclipse.

On the Moon this is a frequent and grandiose phenomenon; on Earth it is seldom and insignificant. A speck of shade, almost the size of a pin head (and sometimes also several versts in length, but what is this, if not a pin head in comparison with magnitude of the Earth?), describes the band on the planet, passing in favorable conditions from city to city and remaining in each of them for several minutes. Here the shadow covers either the whole Moon, or in most cases a significant part of its surface, so that full darkness continues the whole time...

The sickle became still narrower and along with the Sun is hardly noticeable...

The sickle is completely invisible.

We crept out of the ravine and looked at the Sun through dark glass...

It appears as if someone, from the one side of the star, flattened with an invisible gigantic finger its luminescent mass.

Now already there is visible only half of the Sun.

At last the last part of it disappeared, and everything plunged into gloom.

A huge shadow gathered and covered us.

But blindness disappears rapidly. We see the Moon and a great number of stars.

This is not the same Moon — the sickle. This is in form of a dark circle, enveloped in great crimson radiance, especially bright, although pale from the side where the remainder of Sun vanished.

Yes, I see the colors of the dawn, which we once admired from the Earth.

And the environment is flooded with crimson, as if blood...

Thousands of people look at us with naked eyes and through glass, observing the full lunar eclipse...

Native eyes! Can you see us?..

While we were grieving here, the red wreath became more uniform and more beautiful. Here it is equal to the whole circumference of the Moon; this is the center of the eclipse. Here is one side of it, opposite to that where the Sun disappeared, it turned paler and brightened... Here it is becoming more shining and takes the form of a diamond inserted in a red ring...

The diamond turned into a piece of Sun — and the wreath is invisible... Night passes into day — and our numbers vanishes: the former picture appeared before our eyes... We started to talk animatedly.

I said: "We selected shady borough and made observation," but you can ask, "How can you observe the Sun from a shady borough?"

I will answer. "Not all shady places are cold and not all illuminated places are heated. Actually, the temperature of soil depends, mainly upon how much time the Sun heated this place. There is space, which only several hours ago was illuminated by the Sun and up to that time was in the shade. It is understood, that their temperature not only could not be high, but it even is excessively low. Where there are cliffs and steep mountains, casting shade, there is also space, though illuminated, so that from them it is possible to see the Sun, — however, the space is cold. It is true, only sometimes they are not at hand, and before one detects them and reaches them, you will be baked thoroughly — even an umbrella won't save you."

For the sake of convenience and partly for exercise, noting a great number of stones in our crevasse, we decided to haul out a sufficient amount of stones which were not heated so that we could cover with them a certain area, opened from sides, and thusly protect our bodies from heat.

No sooner said, than done...

Thus, we always could emerge up and, sitting in the center of the stone heap, triumphautly make observations.

The stones could be heated!

We can haul new ones, inasmuch as there are many below. Because of strength increased sixfold on the Moon, there too can not be a deficiency.

This we accomplished already after the solar eclipse, which we even did not await with confidence.

Besides this matter, immediately after the eclipse we proceeded to determine the latitude of that site of the Moon on which we found ourselves. That was simple to do considering the epoch of the equinox (it is evident from the eclipse) and the altitude of the Sun. Thus, the latitude of the place turned out to be 40° northern latitude. This means we were not on equator of the Moon.

Thus, the day passed — seven terrestrial diurnal days from the ascent of the Sun, which we did not witness. Actually, the chronometer indicates that the time of our stay on the Moon is equal to five terrestrial days. Consequently, we were on the Moon early in the morning, in the forty-eighth hour. This explains, why when we awakened we found the soil very cold. It did not get heated, having been cooled off excessively by the preceding prolonged fifteen-day night.

....

We slept and awoke and every time saw above us new stars. This all is a familiar pattern on Earth, all were the same stars, only the narrow hole, in which we were located, did not permit us to see simultaneously their great quantity; and they did not blink on the black field, and flowed by twenty-eight times slower.

Jupiter appeared; its satellites can be seen here with the naked eye, and we observed their eclipse.* Jupiter could not be seen anymore. Out came Polaris. Poor one! Here it does not play an important role. The Moon is the only one who will never peek into our ravine, if we should wait for it here a thousand years. It won't peek in because it is eternally motionless. Only the motion of our bodies on this planet can revive it; then it can descend, rise and set... To this question we will return later...

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* An observer from the Moon could not see with a naked eye the satellites of Jupiter and, all the more so, the eclipse of its satellites. — Edit.

....

One can't sleep all the time!

We proceeded to make plans.

— At night we will emerge from the ravine, but not immediately after sunset. When the soil is still heated to almost extreme degrees, but after several tens of hours. Let's visit our dwelling; what is going on there? Was the Sun mischievous? Then we will travel under the Moon's illumination. We will be delighted by the view of the local Moon. Till now we saw it similar to a white cloud; at night we will see it all it's beauty, in all its splendor and from all sides, because it rotates rapidly and will show all of itself in no more than twenty-four hours. In other words, in an insignificant part of the lunar day.

Our great Moon — the Earth — has also phases like the Moon, on which we previously looked from a distance with dreamy curiosity.

In our location the New Moon or New Earth occurs at noon; the first quarter at sunset; the Full Moon at midnight, and the last quarter at sunrise.

We are in a location where night and even days are eternally lunar. This is not bad, but only as long as we are in the hemisphere visible from Earth; but as soon as we pass into another hemisphere; not visible from Earth, then we are immediately deprived of night illumination. We are deprived as long as we are in this unfortunate and, at the same time, so mysterious hemisphere. It is mysterious to the Earth, since the Earth never sees it, and therefore, it intrigues scientists very much. It is unfortunate because its inhabitants, if there are any, are deprived of night illumination and the splendid spectacle.

Actually, are there any inhabitants on the Moon? Who are they? Are they like us? Till now we have not met them, and it is fairly difficult to encounter us because we sat almost on the same place and practiced more gymnastics than selenography. Especially interesting is that unknown half, whose black sky by nights is eternally covered by a mass of stars, for the most part small, telescopic, inasmuch as their delicate radiance is not destroyed by the multiple refractions of the atmosphere and is not muffled by the coarse light of the huge Moon.

Couldn't there be a depression, in which there can be accumulated gases,

liquid and lunar population? Such was the content of the conversations, in which our time was spent, awaiting night and sunset. We awaited it also with impatience. It was not very dull. We did not forget also about the experiments with low-grade olive oil, about which the physicist had spoken previously.

The fact is that we managed to obtain drops of huge dimensions. Thus, a drop of oil from a horizontal plane during fall reached the magnitude of an apple. Drops from a point were much less; through apertures the oil poured two and a half times slower than on Earth during identical conditions. Phenomena of capillarity* appeared on the Moon with sextupled force. Thus, the oil on edges of vessel rose above average level six times stronger.

In a little wine glass the oil looked almost spherical — pressed...

We did not forget also our sinful belly. Every six to ten hours we reinforced ourselves with food and drink.

We had with us a samovar with a tightly screwed cover, and we frequently drank an extract of Chinese herbs.

Certainly, we couldn't let it set in the ordinary way, since for burning of coal and splinters air is necessary. We simply carried it out in the Sun and covered it with especially heated small-stones. It heated rapidly, not to the boiling point. Hot water burst with force from the open tap, impelled by steam pressure, not balanced by weight of the atmosphere.

To drink such tea was not especially pleasant, in view of the possibility of being severely scalded, since the water scattered in all directions like detonated gun powder.

Therefore, putting the tea beforehand into the samovar, we first let it be strongly heated, then we waited while it cooled off away from the hot stones, and finally, we drank the ready tea, not burning our lips. But even this comparatively cold tea burst with noticeable force and boiled weakly in glasses and in our mouth,

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*Capillarity — adhesion of liquid, due to which, for instance, kerosene rises on a wick or juices rise up to leaves; phenomena of capillarity are complicated and are varied. (Here and further below asterisks (*) are used to note the author's remarks. — Edit.).

like seltzer water.

V

Soon the sun set.

We watched as the Sun touched the summit of one of the mountains. On Earth we would look on this phenomenon simply with our eyes — here this is impossible, because here there is neither atmosphere nor water vapor, in consequence of which the Sun did not lose at all its dark-bluishness nor its thermal or light force. To look at it without dark glasses was possible only for a moment. This is not our crimson and weak Sun at sunset and sunrise!..

It descended but slowly. Here already from its first contact to the horizon there passed half an hour, and half of it is still not concealed.

In Petersburg or Moscow the time of sunset is not more than three to five minutes; in the tropic countries it is about two minutes, and only on the pole can it continue for several hours.

Finally, behind the mountains expired the last particle of the Sun, which seemed like a bright star.

But here then is no even glow.

Instead of the twilight we see around us a great number of points shining brightly enough from the reflected light of the summits of mountains and other elevated parts.

This light is sufficient, so that we would not drown in gloom in the course of many hours, if even there were no Moon.

One distant summit, like a lantern, shone for thirty hours.

But it too expired.

Only the Moon and the stars shone for us; but after all, the light force of stars is insignificant.

Immediately after the sunset and even for certain time thereafter, the reflected sunlight predominated above the glow of the Moon.

Now, when the last cone of the mountain is extinguished, the Moon — Master of the night — reigned above the Moon.

Let's turn our glance at it.

It's surface is fifteen times larger than the surface of the terrestrial Moon, which was in comparison as I already said, the same as a cherry behind an apple.

It's luminous intensity exceeds by fifty — sixty times the light of the Moon familiar to us.

One could read without difficulty; it seemed that this was not night, but some fantastic day.

Its radiance did not allow to see neither the zodiacal light nor the stellar small fry without special filters.

What a view! How do you do, Earth! Our hearts beat wearily: neither bitterly, nor sweetly. Rememberances penetrated the soul...

How dear and mysterious is now this Earth which before we scolded and considered commonplace. We see it, as if a picture in closed in blue glass. This glass is the air ocean of the Earth.

We see Africa and part of Asia; the Sahara, the Gobi, Arabia! Countries of drought and cloudless skies! You have no spots, you always are open for the eyes of the selenite. Only when the planet rotates around the axis these deserts by-pass it.

White shapeless scraps and bands — these are clouds.

The land seemed dirty-yellow or dirty-green.

The sea and oceans are dark, but their tints are different — which probably, depends upon the degree of their agitation and rest. There perhaps, on the combs of waves, play the fleecy clouds — as the sea is whitish. Here and there the waters are covered by clouds; not all clouds are snow white, although there are not many grayish ones apparently, they are covered by top light layers, consisting of ice-crystal dust.

Two diametrical ends of the planet shone especially: these are polar snows and ices.

The northern whiteness was cleaner and had a larger surface than the southern.

If the clouds would not move, then it would be difficult to distinguish them from snow. However, snow for the most part lies deeper in the air ocean, and therefore the blue covering it is darker than for clouds.

The brightness of snows of small magnitude we can see scattered over the whole planet and even on the equator — these are summits of mountains, sometimes so high that even in tropic countries their snow cap never melts.

These are Alps glistening!

And these are caucasian summits!

And this is the Himalayan range!

Snow spots are more constant than cloudy ones, but they too (the snows) change, disappear and appear anew with the seasons...

In the telescope it was possible to spot out all the details... We feasted our eyes!

It was the first quarter: dark half of the Earth, illuminated by weak Moon, was distinguished with difficulty and was far more darker than dark (ashy) part of the Moon, visible from the Earth.

We wanted to eat. But before descending into the ravine, we wished to find out if the soil was still hot. We descend from the stone covering arranged by us, already several times renewed, and find ourselves in an impossible melted bath. The heat rapidly penetrates through the soles... Hastily we retreat: it will be long before the soil* cools off.

We dine in the ravine, whose edges now do not shine, though one can see a great number of stars.

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* Since around Moon there is no atmosphere, the cooling of its soil occurs extraordinarily fast. — Edit.

Every two-three hours we emerged and observed the Moon — the Earth.

We could inspect in twenty hours, if this were not hindered by overcast of your planet. From certain places the clouds would obstinately not descend and drove us out of patience, although we had hoped still to see them, and indeed, we observed them, as soon as good weather set in there.

....

For five days we hid in the bowels of the Moon and when we did emerge, then, to the nearest places and for the shortest time.

The soil cooled off and toward the end of the fifth day, terrestrial time, or by the middle of the night by lunar time, it cooled off so much that we decided to start our journey on the Moon: in its valleys and mountains. Actually, we were not in a single low place.

These dark, huge, low spaces of the Moon are called seas, although this is quite incorrect, since there the presence of water is not observed. Wouldn't we find in these "seas" also still lower places of traces of neptunic activity — traces of water, air and organic life, from the opinions of certain scientists, long since disappeared on the Moon? There is an assumption that all this once was here, perhaps even now somewhere in cracks and precipices: there was water and air, but they were sucked in, were absorbed with the passing of centuries by its soil and combined with it chemically, there were also organisms — some vegetation of a simple order, some kind of shell, since where there is water and air, there is also mold, and mold is the beginning of organic life, at least the lowest kind.

Regarding my friend — the physicist, he thinks, and has basis for it, that on the Moon there never was life, neither water nor air. Even if there were water, even if there were air, then it was at such high temperatures that no organic life was possible.

Yes, will the readers pardon me that I express here the personal opinion of my friend the physicist, which hasn't been proven at all.

When we will accomplish a journey round-the-world, then it will be seen who is right.

And thus, seizing the loads, which became significantly lighter because of the large quantity of supplies that had been eaten and drunk, we leave the hospitality of the ravine and the Moon, being on the same place of the black dome, we head to the dwelling which soon we detected.

Wooden shutters and other parts of the home and outbuildings from the same material, subjected to prolonged action of the Sun, were decomposed and were carbonized on the surface. In the yard we found fragments of a barrel of water torn as under by steam pressure; we had carelessly left it closed tightly in the Sun's heat. Of course, there were no traces of the water, it evaporated without remainder. On the porch we found fragments of glass — this was from the lantern, whose mounting was made from fusible metal: naturally it was melted, and the glass flew downwards. In the house we found less damage; thick stone walls provided protection. In the cellar all turned out to be intact.

Taking from the cellar the supplies necessary to keep us from dying of thirst and hunger, we departed for our prolonged journey to the pole of the Moon and to the other, mysterious hemispheres, still not seen by anyone.

— Should we run after the Sun westward, — suggested the physicist, — declining gradually to one of the poles? Then we can simultaneously kill two birds: the first, — reaching the pole and the moonless hemisphere; the second, — avoiding excessive cold, since if we will not lag behind the Sun, we will run over places heated by the Sun at definite times, — consequently, over places with constant temperature. We can even arbitrarily, by measure of necessity, change the temperature: surpassing the Sun, we will increase the temperature, and by lagging behind — lowering the temperature. It is especially good, considering that we will approach the pole, whose average temperature is low.

— That's enough, can this be so? — I noted to the strange theories of the physicist.

— Very possible, — he answered. — Take only into account the ease of running on the Moon and the slow motion (apparent) of the Sun. Actually, the biggest lunar circle has about ten thousand versts in extent. This distance would have to be covered, in order not to lag behind the Sun in thirty terrestrial days or seven hundred hours, expressed in the Earth language. Consequently, in an hour one must run fourteen and a half versts.

— On the Moon fourteen versts per hour! — I exclaimed.

— I look at this number not otherwise as with contempt.

— Well, you will see.

— While joking will run twice more! — I continued, remembering our mutual gymnastic exercises. — And then it is possible in each twelve hours to sleep as much...

— Other parallels, — explained the physicist, —are the smaller, the nearer to the pole, and since we are heading namely through this point we can run with gradually lowering speed, not be lagging behind the Sun. However, the cold of the polar countries will not allow this to happen: as we near the pole we should, in order not to freeze, approach the Sun, that is run in locations which are subjected to prolonged illumination by the Sun. The polar Sun is low above horizon, and therefore the heating of the soil is incomparably weaker, so that even during the actual sunset the soil is only warm.

The nearer to the pole, the closer we should be to the sunset, for the greater possible constancy of temperature.

— Westward, westward!

We slide, like the shadows, as apparitions, noiselessly touching with our feet the pleasantly warm soil. The Moon had almost completed the circle and, therefore, shone very brightly, presenting a fascinating picture, covered by blue glass, whose thickness seemed to increase at the edges, since the closer to it the darker it gets; from the edges one can't distinguish either dry land, water, nor the cloud formation.

Now we see the hem'sphere which is abundant in dry lands; in twelve hours it would be to the contrary, abundant in water, — almost the Pacific Ocean; it poorly reflects the Sun's rays and if not for the clouds and ice which shone brightly, the Moon would not have been as bright as at present.

Easily we run up to the heights and even more easily we run down from them. Occasionally we are immersed in shade, from which more stars are visible. So far we apprehend only small hills. However, even the highest mountains would present no obstacles, since here the temperature of location does depend upon its height: the summits of mountains are also warm and free from snow, just as the low valleys... Uneven spaces, banks, ravines are not frightening on the Moon. We jump over uneven spaces and ravines reaching in width from 10 to 15 sagenes, and if they are very big and are inaccessible, then we try to bypass on the side or crawl on the steepnesses and step with the help of thin twigs, sticks with hooks and with spike soles.

You will remember our small weight, which does not require us to be supported by ropes, — and you will understand everything.

— Why do we not run to the equator? After all we haven't been there — I noted.

— Nothing hinders us getting there, — agreed the physicist.

And we immediately changed our course.

We ran too fast, and therefore the soil became warmer; at last from heat it became impossible to run, since we reached places which were more heated by the Sun.

— What will happen — I asked, — if we were to run, disregarding any heat, at this speed and the same direction — to the west?

— According to Earth's calculation in about seven days after such a run would we see the summits of mountains illuminated by the Sun, and subsequently we would see the Sun rising in the west.

Could it be possible that the Sun would rise where it ordinarily sets? — I questioned doubtfully.

— Yes, this is true, and if we were fantastic salamanders, inured against burning, we could be convinced with our own eyes regarding this phenomenon.

— What will happen then? Will the Sun only appear and then again disappear or will ascend in the usual order?

— As long as we run; let's presume, along the equator with a speed exceeding fourteen and a half versts, the Sun will move from west eastward, where it will set; but should we stop, it will immediately move in the usual manner and, that which was elevated by force from the west, again will plunge behind the horizon.

— And what, if we will not run any faster than fourteen and a half versts per hour, what will occur then? — I continued.

— Then, as in the times of Joshua, the Sun will stop in the sky and day or night will never come to an end.

— Is it possible also on Earth to do all these things? — I pestered the physicist.

— It is possible, only if you are in a condition to run, to ride or to fly on Earth with the speed of one thousand five hundred forty versts per hour and more.

— What? In fifteen times faster than a storm or hurricane? Well, this I do not undertake... forget it — I would not try it!

— That's it! What is possible here, and even easy, there on Earth, — the physicist pointed his finger to the Moon — quite inconceivable.

Thus we reasoned seated on the stones, since owing to the heat it was impossible to run, as I already said.

Fatigued, we quickly fell asleep.

We awakened significantly refreshed. Cheerfully arising and jumping up five arshins we again ran westward, bending toward the equator.

You will remember, we determined the latitude of our cabin to be 40°; therefore to equator there remained a respectable distance. But please do not consider the degree of latitude on the Moon as the same length as on Earth. Do not forget that

the size of the Moon is to the size of the Earth, as a cherry is to an apple; the degree of lunar latitude, therefore, is no more than thirty versts, whereas a degree of Earth latitude is one hundred four versts.

About our approximation to the equator we, incidentally, were convinced by the fact that the temperature of deep crevices, on the average, gradually was increased and, having attained an altitude of 50 degrees by Re'aum'ur, stopped at this magnitude; later it even began to decrease, which indicated transition to the other hemisphere.

We determined a more exact position astronomically.

But before we crossed the equator, we encountered many mountains and dry "seas."

The form of lunar mountains is well known to the inhabitants of the Earth. This is for the most part, a circular mountain with a basin in the center.

The basin is not always empty, is not always the newest crater: in the center of it there is sometimes still another mountain and again with a depression, which turns out to be a newer crater, but very rarely active — with reddening lava inside of it, on the very bottom.

Did not volcanoes in the days of the eject quite often the stones found by us? Any other origin would be incomprehensible to me.

From curiosity we purposely ran close to volcanoes, on their actual edge, and, looking inside the craters saw twice sparkling and overflowing waves of lava.

Once to the side we even noted the summit of one of the mountains a huge and high beam of light, consisting, probably, of a large number of stones heated to the point of glowing; the tremor from their fall reached even our legs, so light here.

Due to deficiency of oxygen on the Moon or due to other causes, we only found unoxidized metals and minerals, more frequently aluminum.

Low, even level spaces, dry "seas" in other places despite the convictions of the physicist, were covered by evident, although pitiful, traces of neptunic activity. We liked these depressions, somewhat dusty from contact of feet, but we ran

so quickly that the dust remained behind us and immediately settled, since there was no wind to blow it into our eyes and nose. We loved them because they cushioned the heels in rocky places, and they replaced for us soft carpets or grass. This floating layer could not hamper our race because of its small thickness, not exceeding several inches or lines.

The physicist indicated to me by hand far away, and I could see from the right side something like a campfire, spattering red sparks in all directions. The latter described beautiful arcs.

In agreement we make a detour, in order to see for ourselves the cause of this phenomenon.

When we came to the place, we saw scattered pieces of more or less incandescent iron. Little pieces had already cooled off; the larger ones were still red.

— This is meteoric iron, — said the physicist, taking in hands one of the cooling pieces of aerolite. — The same pieces drop also on Earth, — he continued. — More than once I saw them in museums. Only the name of these celestial stones, or, more exactly, bodies is incorrect. Especially here is this name inapplicable, on the Moon, where there is no atmosphere. They also are not visible here until they strike against granite soil and become heated as a consequence of transformation of the work of their motion into heat. On Earth they are noticeable at the instant of entry into atmosphere, since they are heated in it by air friction.

Crossing the equator, we resolved again to swerve toward the North Pole.

Surprising were the cliffs and heaps of stones.

Their form and position were daring enough. Nothing similar did we see on Earth.

If one were to transport them there, that is on your planet, they unavoidably would collapse with a terrible rumble. Here however, their odd forms are explained by small weight, not capable of tumbling them.

We rushed and rushed, getting closer and closer to the pole. The temperature decreased in the cracks. On the surface we did not feel this, because we began

gradually to overtake the Sun. Soon there awaited us the sight of the wonderful ascent of it in the west.

We were not running fast, there was no need to.

We no longer descended into the cracks for sleep, because we did not need the cold, and rested and ate directly where we stopped.

We fell asleep also while running, surrendering to incoherent dreams. There is no need to be surprised by this, knowing that similar facts are observed on Earth; they are possible all the more so here, where to stand is the same as to lie down (speaking about weight).

VI

The Moon descended lower, illuminating us and the lunar landscapes sometimes weaker, then stronger, depending on which side it turned to us (water side or soil side) or depending to what degree its atmosphere was saturated by clouds.

There came a time when the Moon touched the horizon and began to set behind it — this signified that we reached the other hemisphere, not visible from Earth.

In about four hours it completely disappeared, and we saw only several summits illuminated by it. But they also expired. The darkness was remarkable. Stars — abyss! Only in a descent size telescope was it possible to see so many of them from Earth.

Unpleasant, however, is their lifelessness, immobility, far from the immobility of the blue sky of the tropic countries.

And the black background is severe!

What is this so strongly far off that gleams?

In half an hour we will learn that this is a top of a mountain. More and more summits started to shine.

We will have to run up the mountain. Half of it shines. There is the Sun! But while we climbed the mountain, it already succeeded to plunge into darkness, and the Sun could not be seen from it.

Evidently, this is the site of sunset.

We proceeded faster.

We fly like arrows launched from a bow.

We didn't need to hurry so; all the same we could have seen the Sun, rising in the west, had we run even with a speed of 5 versts per hour; that is, not running — what sort of running is this! — We walked.

No — it is impossible not to hurry.

And here, oh what a miracle!..

The ascending star shone in the west.

Its dimension increased rapidly... A whole section of the Sun is seen... The whole Sun! It rises, is separated from the horizon... Higher and higher!

And meanwhile, all this is only for us, the running ones; the summits of mountains, remaining behind us, are extinguished one after another.

If we do not look upon these approaching shadows the illusion would be complete.

— Enough, we are tired! — humorously exclaimed the physicist, turning to the Sun. — You can go to rest now.

We sat down and waited for that moment when the Sun, setting in the usual manner, would disappear from view.

— The comedy is ended!

We tossed around and fell soundly asleep.

When we awoke, we again, but unhurriedly, only for the sake of heat and light, overtook the Sun and kept it in sight. It would rise, then descend, but was constantly in the sky and did not cease to warm us. We fell asleep — the Sun was high enough; we awoke — the rascal Sun had attempted to set, but we tamed it in time and forced it again to rise.

We approach the pole!

The Sun is so low and the shade is so great that crossing them, we shivered considerably. In general, the contrast in temperatures is striking. Any outstanding

place would heat to a point that it was impossible to approach it closely. Other places, being in the shade fifteen and more days (Earth time) are impossible to pass, for fear of contracting rheumatism. Do not forget that here the Sun, also almost being on the horizon, heats the stone's surface (those facing its rays) not any less, and actually about twice stronger than the terrestrial Sun, when it is directly overhead. Certainly, this cannot be in polar countries of the Earth, because the strength of solar rays, first of all, is almost absorbed by thickness of the atmosphere; in the second place, you do not have it shine as brightly on the pole. Each twenty-four hours the light and the Sun pass the stone around, although they do not let it out of sight.

You will say, "And thermal conductivity? The heat of the stone or mountain should pass into the cold and rocky soil?" — "Sometimes, — I will answer, — it does not pass over, when the mountain is a whole with the mainland. However, a great number of chunks of another granite, in spite of their own size, are simply cast aside and touch the soil or chunk only at three or four points. Through these points the heat leaves extremely slowly; it is better to say — inconspicuously. And here the mass is heated and heated, radiation is so weak."

These were not the stones which hampered us, however, but the very cold ones lying in the shade of the valley. They hindered our approach to the pole, because the nearer one approaches to it, the more extensive and more impassable are the shady areas.

There should still be seasons that are more noticeable, otherwise they are here almost nonexistant: in the summer the Sun on the pole does not rise higher than 5°, while on Earth this increased five times.

And when will we finally have summer which, probably, also will permit us, half-heartedly, to reach the pole?

Thus, advancing in the same direction after the Sun and making a circle, or, more correctly, a spiral, on the Moon we again depart from this point, frozen in

places and with hot stones piled everywhere.

We did not want to be chilled nor to be burned!.. We retreated ar retreated.. It becomes hotter and hotter... We are forced to lose the Sun. We a , forced to lag behind it in order not to be roasted. We run in darkness, at f rst a lorned somewhat by light from the summits of mountain ranges. But they re already gone. It is easier to run: much has been eaten and much has been drunk.

Soon the Moon will appear, which we forced to move.

Here it is.

We welcome you, on dear Earth!

Not jokingly we greeted it!

I should say. To be so long apart!

Still many hours followed. Although these places and mountains we have never seen, still they do not attract our curiosity and seem monotonous. We are tired of all these miracles! Heart is weary, the heart aches. The view is excellent, but not worthy of the Earth; it only brings forth pain or recollections, pain of irrevocable-loss. If only faster to reach the dwelling! I can't sleep! But there also, in the dwelling what awaits us? Familiar, but inanimate objects, are capable of hurting ones heart more.

Where from this depression?.. Before we hardly knew it. Did not the interest of surroundings disguise it then not succeeding yet to tire the interest of novelty?

Faster to the dwelling, so that we shall not see these dead stars and the mourning sky!

The dwelling should probably be close by. It is here, astronomically we established this, but in spite of the indisputable indications, we not only do not find the familiar yard, but do not even recognize a single view, not a single mountain, which should be so well known to us.

We walk and search.

Here and there! They are nowhere.

In desperation we sit down and fall asleep.

The cold awakens us.

We reinforce ourselves with food, of which already is growing scant.

We have to save ourselves from the cold by escape.

As if in spite, we do not find a single suitable crevise, where we could hide from the cold.

Again we have to run after the Sun. To run like slaves, fixed to chariots! To run eternally!

Oh, distance is not eternal! There remains only one portion of food.

What then?

The portion is eaten, the last portion!

Sleep closed our eyes. The cold forced us to press fraternally close one to another.

And what happened to these ravines, of which we found so many when we did not need them?

We did not sleep long: the cold, still more severe, awakened us. Unceremonious and merciless, it did not give us even three hours to sleep. It did not let us have full rest.

Powerless, weakened by depression, hunger, and the approaching cold, we could not run with our former speed.

We froze!

Sleep overtook me — and the physicist upheld his friend, — and then it would overtake him; and I too would withhold from sleep, from mortal sleep, the physicist, who taught me to grasp the meaning of this terrible, last lulling sleep.

We supported and encouraged each other. It did not occur to us, as I now remember, to abandon one another and to delay the hour of the end.

The physicist slept and raved about the Earth; I embraced his body, trying to warm him with mine.

....

Tempting dreams about a warm bed, of a fire in a fireplace, about food and wine overcame me... I am surrounded by the folks... They wait on me, pity me... Serve me...

....

Dreams, dreams! Blue sky, snow on the neighboring roofs... A bird flew by... Faces, faces of acquaintances... Doctor... What is he saying?..

— Lethargy, prolonged sleep, dangerous situation... Significant decrease in weight. Lost a lot of weight... That's alright! Breathing has improved... Sensitivity is being restored... The danger has passed.

All around are joyful, although with tear-stained faces...

In brief, I slept a sickly sleep and now I awakened: I lay on the Earth and was awakened on the Earth; my body remained here, however, my thought flew away to the Moon.

Nonetheless, I was delirious for a long time. I asked about the physicist, talked about the Moon, was surprised how my friends got on the Moon. I confused the earthly with the celestial, then would imagine myself on the Earth, then again returned on the Moon.

The doctor did not recommend to argue with me and to irritate me... He feared madness.

Very slowly I regained consciousness and still slower recovered.

Needless to say, the physicist was very surprised, when I, after recovery, told him this whole histo_y. He advised me to record it and to supplement somewhat with my own explanations.

DREAMS ABOUT THE EARTH AND THE SKY

I

External Structure of the Universe

(Introduction)

1. Size of Earth. If one were to travel continuously day and night, both "sea, and on land," at a rate of 4 1/2 kilometers* per hour, in a year of such unhindered and tireless procession we will have circled the whole globe around its major circumference.

If one were to use only one second for inspection of each square kilometer of Earth, then for the inspection of its whole surface it would take 16 years; for the inspection of land alone 4 to 5 years would be necessary. If one were to inspect in each second each dessiatine of it, 400 - 500 years would be necessary. In spite of the huge half a billion population of the globe, for each square kilometer of its surface on an average there are only 3 persons. For one man there are nearly

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* I have used metric and Russian measure here interchangeably. Approximately: kilometers equal versts, meters — half-sagenes (1.4 arshin) [1 arshin = 71.12 cm (Ed. note)], millimeters — half-lines, a hectare is equal to approximately one dessiatine [1 dessiatine = 2.70 acres (Ed. note)], a square kilometer is 100 dessiatines, a gram is from 1/5 to 1/4 zolotniks [1 zolotnik = 4.266 grams (Ed. note)], and a ton is 60 poods [1 pood = 16.38 kg (Ed. note]. I believe that I have used no other metric units of measure.

33 dessiatines with the seas, and land alone — about 8 dessiatines. Per family of 6 people 2 square km. of sea and land, or about 200 dessiatines (200 hectares) are needed.

If one were to assume that the Earth is separated into cubes and that for the inspection of every cubic kilometer of it one second is sufficient, then for inspection of the whole mass of the Earth, on the outside and inside, 32,000 years are necessary. The size of the Earth in comparison with the size of a magnificent fantastic palace (60 sagenes in length, width, and height) is the same as this very palace in comparison with a tiny drop (1/2 line in thickness).

For each man there is allotted a volume equal to the volume of a small planet of 10 versts in diameter, or a square field a thousand versts long, of the same width and one arshin in thickness.

2. <u>Comparative dimensions of water, atmosphere, mountains, and hard shell</u>. Let us imagine the Earth in the form of a polished ball, the length of an index finger in diameter (120 millimeters). The smallest particles sticking to it (1/10 millimeters) will depict the altitude of the greatest mountains. We will dip the sphere into water and we will shake off from it the drops; the layer of water adhering to it is the deepest of oceans. The atmosphere, having an altitude up to 300 versts, on our sphere is in the form of a layer of liquid, a thickness of a line (2.5 millimeters). If, however, one were to depict only the layer of air, in which a person can breathe, then on our sphere it will not be thicker than a cigarette paper.

The temperature of Earth's soil with the removal from its surface is gradually increased; this gives cause to think that only an insignificant part of the Earth is cold and in solid state, its internal mass is hot, molten and is liquid;* this hard crust, by our scale, can possibly be depicted by a thin cardboard layer 1/4 line in thickness (thickness approximately of a visiting card).

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*However, the terrestrial mass is in liquid form only under the core, but deeper the terrible pressure prevents its melting in spite of the monstrous temperature. Mechanics-astronomers also find that in general the globe is a solid body.

3. Dimensions of members of the planet system. If one were to assume that the Earth is a pea (5 millimeters), the Sun is a giant watermelon (550 millimeters), the Moon is an undersized granule (1 1/2 millimeters), Jupiter is a bigger apple (56 millimeters), Saturn is a smaller apple, but with a thin ring embracing it, not touching the apple, Uranus and Neptune are two cherries, the other planets and satellites are small peas and seeds,* asteroids are sand grains and dust particles.

4. Distances of members of this system. The absolute distances of celestial bodies so are huge that the numbers expressing them in usual measures, exceed the limits of our imaginations.

Thus, from Earth to the Sun it is necessary to travel day and night, in order to pass this distance of 4 thousand years. This means that it will take 25 thousand years to go around the Sun by annual movement of the Earth. It will take almost a million years to traverse the orbit of Neptune, which it itself passes in 165 years, with a speed of 5.3 kilometers per second. The figures that we gave for the determination of time of passage of interstellar spaces are quite inconceivable: they are easy to write and to pronounce, but not easy to comprehend.

By decreasing the interplanetary spaces in proportion to the decrease of the celestial bodies themselves, we will find that the pea-Earth should lag behind the watermelon-Sun by 180 steps (120 meters), apple-Jupiter — by 300 sagenes, Neptune — by 3 and more versts.

Thus, the Earth is lost in the planet system know to us (up to Neptune), like a pea thrown into a round field of 3,000 dessiatines!

The grain-Moon will lag behind the pea-Earth by less than 1/4 arshin (100 millimeters).

5. Motion of the planet system. All these apples, peas, grains, sand, and dust particles not only rotate like children's tops, but also rotate around the watermelon-Sun, which relative to them is almost motionless and only revolves around itself.

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*Planet of Agate is not more than 6 kilometers in diameter.

The planet system is as if in one field that carries away with itself in straight direction all that is on it all moving and motionless objects.

It is remarkable that the axes of rotation of almost all the members of the planet system are approximately directed in one direction; they are as if on one imaginary field: still more remarkable is that the rotation and movement around the Sun is accomplished in one direction. Namely, if we were to stand on the north pole of the Earth or Sun, we would note their movement in counterclockwise direction. Such is also the motion of the planet satellites.

6. Speeds of the planets. The pea-Earth rotates around itself once every twenty-four hours, and around the watermelon-Sun makes one circle in a whole year. The closer the planets or the balls depicting them to the watermelon-Sun, the faster their motion, and the further the planet — the slower the motion. The same is true relative to planet satellites. Jupiter with its own satellites depicts in miniature form the actual planet system, with the exception of that here the central body (Jupiter) does not shine independently.*

Although our peas and cherries move very slowly, and rotate also quite sluggishly, nonetheless, the true speeds of these motions by far are no such. For instance, the edges of the Earth, far from the axis of rotation, move like bullets and bombs of the heaviest armament; the large planets revolve much faster. In general, it is very difficult to imagine the motion of all points of the celestial body around the Sun. The Earth, for instance, makes each second nearly 27 versts. If only a particle of Earth, in size and mass is equal to a bomb striking against a motionless wall, then the energy of this steady motion would be 2 - 3 thousand times more terrible than the destructive action of the best military weapon. If a stone was thrown from the surface of the Earth with the speed at which the Earth moves around the Sun, this stone will forever be gone from the globe and, eternally flying in one direction, would lose less than half of its initial speed.

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*If Jupiter does shine, then very weakly, and the glow is like the glow of an active terrestrial volcano, only more grandiose.

7. <u>Concept of the velocity of light, which will serve us for the following presentation</u>. The velocity of light is such that in one second it traverses the Earth 7 - 8 times. The light traverses the planet space with approximately the same ease with which a fly moves from one end of a room to the other, or like a bird — from one part of a city to a neighboring one. Thus, a ray of light reaches the Earth from the Moon in almost 1 second, and from the Sun to the Earth — in 8 minutes, and the whole planet system known to us, from Neptune to the Sun and back — in 8 hours. Yes, the planet system, nevertheless, is not small, if even for the fast ray of light it presents, more than for the traveler, a distance of 30 versts! (Since this distance the traveler will make in less than 8 hours).

After all, light travels 500,000 times faster than gun shell, which should travel the distance, passed by the ray in 8 hours, during 400 - 500 years...

8. <u>Milky Way</u>. The Milky Way is an accumulation of billions (literally, and not in the sense of a great number; I will always express myself as accurately as possible) of stars, or suns, occupying in totality a disk-like space resembling a flat cake or a pressed sphere, and located from each other at great distances. Everything visible to the naked eye in the stellar sky, together with the nebulous band of stars, distinguished only by telescopes, is the Milky Way. The stars which seem big are nearer to us, the small ones in general, are farther away, and the smallest are seen remotely in a whitish haze. We and our Earth are approximately in the middle of the Milky Way; across it we see the stars only comparatively close, which, therefore, do not merge into one nebulous mass; lengthwise, we observe such a great number and such distant stars that they appear to us in a fog.

The Sun is one of the stars of the Milky Way, but we are at such a close distance to it that it blinds us, all the stars are such, if one were close to them; the exception being the satellites of suns* — planets and satellites of planets.

*If the satellite of a sun (i.e., star) is very great, then it did not cool off yet and, therefore, shines like the sun; such a system is called a binary star; there are multiple, or compound stars.

With the naked eye one can see not more than 10 of them. Illuminated by the sun and comparatively very close to us, they seem to us as stars, but if one were to approach them, they will be pitiful planets like the Moon. With telescopes one can see hundreds of them; all these are satellites of our Sun; satellites of other suns cannot be seen because of their remoteness.*

The distance to the nearest stars is so great that even by decreasing it as we decreased Earth, imagining it as a pea, we will get a thousand versts. And thus, the stars in our picture (in our miniature) are self-luminous watermelons of different magnitudes, located a thousand versts from one another.

However, how bright should the light of such watermelons be, in order to be visible at a thousand versts! Therefore, certain stars in our model are the size of a mountain. Thus, Sirius will be nearly 3 sagenes in diameter.

Considering the solar system as an average space, in the Milky Way per star, let us say that the Earth is lost in it like a drop of water in the oceans.

This space, or distance to the neighboring stars is so huge that even a fast ray of light takes years to travel it. According to telescopes, light takes thousands of years to traverse the entire known Milky Way. The smallest Infusoria, hardly distinguishable in the microscope, in its dimensions has incomparably greater meaning in the waters of the Earth than the Earth in the Milky Way. I imply here, of course, the value of Earth is not spiritual, but only with respect to the space occupied by it.

9. The grandeur of the Universe. The Milky Way has such a great number of stars that if all of them merged into one, it would be the size of such a sun which would occupy the planet system, at least, upto Jupiter.

But the Milky Way is not unique, there are numerous clusters of stars similar to it. From the Earth, i.e., from our Milky Way, these clusters are presented in

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*Besides the huge — luminescent ones.

the form of telescopic nebulous specks of more or less round form.* Their number can be just as great, as the number of stars in the Milky Way.

The distance between Milky Way is colossal and requires for its passage, with the velocity of light, a million years.

Had they appeared 100 - 200 thousands years ago, we could not have seen them now, because the ray of light during this time would not reach us. They should have appeared a million years ago in order for us to see them now. <...> .**

The group of Milky Ways in all likelihood constitutes still another unit of a higher order...

10. Stellar motion. I said that the imaginary field of our planet system, as though attracted by a storm, moves in straight direction, so that the Sun also passes each second several tens of versts. Similar velocities, but in different directions, are also possessed by all of the observed stars. Only the velocity of distant stars is extraordinarily difficult to measure, and even now it is impossible. Other stars travel hundreds of versts per second and, in spite of such velocity of motions, their movement is impossible to note with the naked eye even in milleniums.

Hence the incorrect, although commonly used term, "fixed stars."

The cause of this is the great distances between stars. If the nearest star decided to traverse around the Sun or us (which is the same, since we, comparatively, are with the Sun almost at one point) with the velocity of light, also then for this there would be needed years or tens of years. How much time is necessary for a star to travel its natural course, which is hundreds of thousand times less!

For that, the star would need a million years, and in thousands of years it would travel only a small fraction of a degree.

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*That such a speck is not a rarefied gas — the ancestor of the suns and planets — can be seen in the characteristics of its spectrum, differing from the spectrum of a gas and peculiar only to incandescent solid bodies and stars.

**In square brackets here and below are lines in the text. — Editor.

Had we lived and thought exceptionally slowly, so that a century would turn out to be for us one second, we would see with our own eyes a wonderful spectacle of gliding stars in various directions. The brightness of some would be intensified, of others, it would be weakened. Others would travel so closely that their light would blind us... However, the Milky Way, in its remoteness, would seem unchanged for a long time yet.

11. The view from various points of the Universe. What will a man see, passing with an arbitrary speed from one point of the Universe to another? Since he surely heads from the Earth, first of all he will note how fast the Earth becomes smaller, occupying in the beginning somewhat less than half of the sky in the form of a grayish cup, into whose interior he is looking. The cup becomes smaller and smaller and is transformed into a gigantic saucer.

Sun will change much slower; in order not to burn ourselves, we will depart from it, as a consequence of which we will dress warmer. The form of the stellar sky will remain the same for a long time, but now the Sun has already turned into a star; Earth and other planets long ago could not be seen, the pattern of constellations visible is not the same, only the small stars in the Milky Way are the same.

We will fly faster; then all the big stars will appear to be in motion — as trees in the forest to a traveller passing by them quickly; some of them would come closer and would shine stronger, others would depart and disappear from our eyes. We will fly still faster, because we are already tired with this change of scenery. If we are moving along the "flat cake" of the Milky Way, its nebula on one side is more and more decomposed into stars and, finally disappears. The stars are all around, but the Milky Way is in the form of a semicircle -- only on one side... Now even the stars are visible only from one side... Stars become dimmer, diminish, vanish, and there remains only the arc of the Milky Way... this arc gradually decreases, turning into a nebulous speck.

I look up and see many of the same nebulous specks around. These are other Milky Ways. I see neither stars, nor the Sun around, but only some of these specks, barely white... I fly through the whole group of specks, which I cast behind, in one heap. The heap decreases and disappears... Complete darkness... Could this really be the end to everything, the limits of the world?! Not so! We fly faster in that same direction: and here, from the darkness there stands out another group of specks — not those that we just left behind... All is repeated in reverse order, and we enter into a new world, about whose existence we can only guess.

And how many of such worlds are there, how many such humble, from infinity, compliments of specks?!.. <...>

II

Universal Attraction

12. How weak is the mutual attraction of terrestrial bodies. A stone drops into a well, a one-pood measure presses on the floor — this is weight. The cause of it so far is an inexplicable property of matter to attract to itself another matter, similar to the way a magnet attracts iron, but to a much lesser degree. Although there were many attempts to explain universal attraction, nonetheless, all these explanations were not satisfactory* and, therefore, were cast aside. Furthermore, they introduce such principles, which were no more understood than the mutual tendency of all bodies at a distance. Some inexplicable principle had to be taken. It would be better to take for such a principle the law of gravitation, which is absolutely clear, is expressed mathematically and already explained the mass of phenomena.

The force of attraction of a given spherical or pointed mass decreases (upon going away from it), similar to depreciation of luminous intensity upon going away

*The wittiest of them is Lesage's, in 1818.

from its spherical source. But apparently, there is very little in common between gravitation and such partial forces. In actuality, gravitation does not disappear, is not exhausted, does not depend upon temperature and illumination, and does not require time for its propagation. To the contrary, for example, an incandescent or luminescent object would be attracted to the Earth with an inconstant force, i.e., would weigh differently than on one has yet resolutely observed. And also different parts of the globe, which are heated differently, would reveal the tendency to burst or to distort the form of Earth. The Earth and the Moon, being physically different, could not have a coordinated motion around the Sun.

And thus, all bodies at any distance attract one another.

But only very exact and difficult experiments* reveal the attraction of terrestrial bodies among themselves, because even the attraction of such masses as mountains is extraordinarily small. The mass of Earth is great, and that is why we easily notice its action.

The attraction of small bodies would be revealed in their approach, if friction did not prevent it. Two fat men attract each other at a distance of a meter with a force of 1/20 milligrams (a milligram is the weight of the smallest drop of water, 1/4500 zolotnik). Even if this force will bend a hair one meter long into an arc, in this case, it will not tear it, — it will not tear even the finest cobwed. Can it, after that, move two men — conquer their comparatively great friction against the soil on which they stand!

A ton (61 pood) and a ton in spherical form, at a distance of one meter in their centers, are attracted with a force of 6 2/3 milligrams (1/670 zolotnik).

12_1. <u>Force and law of attraction of a given mass depends upon its form and density</u>. Do not think that the gravity force of a given mass depends exclusively upon its magnitude, or the distance and mass of the attracted body! Only for

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*The most exact experiments were performed by Cavendish, regarding the attraction of spheres and by Maskline, regarding the attraction of mountains. Era's experiment is also known — in mines.

spheres or material points is attraction proportionate to the composition of attracted masses and inverse to the square of their distance. For bodies of other form, the laws of gravitation are capricious enough. For instance, an infinite plate limited by two parallel planes, and hence, also an infinite mass, should attract with infinite force; however, this is not so. The attraction is quite weak; depending upon the thickness and density of the plate, it is normal in relation to it and equal everywhere, at any distance from it.

If the distance of the object is small in comparison to the magnitude of the plate, then during calculation it is possible to take it as infinite; so that, as we saw that for one inhabitant of the Earth is alloted its mass, equal to the mass of a flat square field 1,000 versts, in length and in width, and 1 arshin in thickness (its density should be equal to the average density of the Earth, or 5.5). A man, walking on it, will experience, on almost all its space and at altitudes up to several tens of versts, the identical attraction (as though the plate was infinite), which is 6 million times less than the Earth's, or 2,000 - 3,000 times less than on the surface of asteroid 6 versts in thickness (description 31).*

So that the infinite material plate of the density of Earth would render attraction equal to the Earth's should be 4 thousand versts in thickness (2/3 of the terrestrial radius).

But then the attraction of such plane does not decrease at any distance and does not change its direction (on the other side of the plate of course, the direction of weight in reversed).

If the Earth were flattened as if into a disk (flat cake), the thinner such a plate is the less would be the attraction. Thus, theoretically, the attraction of Earth may be decreased according to ones wishes. And so that the mutual attraction of parts of the crushed planet would not bend it into a tube or again turn into an astronomical droplet; it is possible to give the disk a weak rotation, destroying (by centrifugal force) the attraction and preventing destruction of the disk.

* Agate.

Disintegration of the spherical planet also depreciates the attraction on its surface and inside it; for instance, decrease of density, without disturbance of mass, decreases 8 times the attraction 4 times; disintegration 1,000 times depreciates weight 100 times.

Sometimes arbitrarily huge masses do not produce any mechanical influence on bodies.

Thus, an empty sphere with concentric walls and an empty cylindrical pipe with the same walls* do not produce any mechanical influence on the bodies placed inside of them, — not only in geometric center, but anywhere else. The external attraction of the pipe is inverse to the distance of the object from its axis. External attraction of the sphere, however, is inverse to the square of the distance from its center.

13. Influence of gravitation on shape of the planet; weight on various planets. We know, how striking the celestial bodies are in their dimensions, and only they clearly reveal their attractive force.

Due to gravitation, all suns and big planets have the form of almost perfect drops. If celestial bodies were cold and were created from the most durable material, such as, for instance, steel, also then in another form, not round, they would have instantly crumbled and become rounded. There would remain comparatively insignificant unevenness, like sand grains on a polished ball.

Attraction on the surface of various suns and planets is different, depending upon their mass and density.

If on Earth a man lifts 5 poods and jumps over a chair, on the Moon he could lift a cow and jump over a high fence. On the Sun he would not be able to stand, would fall and would be smashed to death by his own weight, which is 27 1/2 times heavier there than on Earth. On Mars and Mercury he could lift 10 - 15 [terrestrial] poods and would easily jump over a table. On Jupiter, and without a load,

*Valid in the case when the pipe was infinitely long. — Edit.

he will hardly be dragging, — as if on his shoulders he had an excessively stout person. On asteroids he would lift homes, jump over the highest trees, belfries, woods, wide ravines, and quite sizeable mountains, depending upon the dimensions of the asteroids on which he makes these experiments. Finally, on aerolites, several tens of sagenes in magnitude, he does not notice weight at all.

The gravity force on various planets limits the altitude of mountains, buildings, and organisms. On Moon the mountains could have been 6 times higher than on Earth, and if they were equal to the terrestrial ones, this is only by chance or due to friability of the material of the lunar mountains. After all, even on Earth the altitude of mountains does not attain maximum. On asteroids, the unevenness is so great that it exceeds the dimensions of the planet itself; that is why their form is infinitely varied and could not necessarily be spherical. They appear in either form of faulty stone or fragments, or in the form of a disk, ring, etc. (This is one assumption: their form cannot be distinguished in a telescope and this conclusion we made partly theoretically, partly by the extreme changeability of their light force.) Revolving, they reflect more, the smaller the quantity of solar rays and seem, in the telescope of the observer, as variable stars of all possible magnitudes.

If the size of a man on Earth (with that same form) was 2 - 3 times greater, he would hardly drag along it; if 6 times greater, he could only lie on a soft bed or stand in water. Meanwhile, on the Moon, the same five-sagene giant would feel himself absolutely free.

On asteroids the motion of giants by the height of a huge belfry and higher are free: a giant, reaching with his hand the top of the Eifel Tower, and weighing 334,000 tons (more than 20 million poods), jumps and plays like a kid on some asteroid, 150 kilometers in circumference (assuming spherical form) and average terrestrial density. Conversely, on the Sun there could live only Liliputians 1 1/2 vershoks high (6.6 centimeters).

Let us note that in regards to the similar structure of organisms, these conclusions are strictly mathematical.

The influence of weight on the form of a planet is complicated by their rotation around their axes.

Due to rotation, all planets and Sun are more or less pressed in the direction of their axes. If the rotation was continuously accelerated, the planet would at first be turned into a flat cake, then into a ring with a central spheroid; the ring could burst into parts, revolving around the center of the body.

Thus, perhaps, Saturn was formed with its rings and other planets with their satellites; thus, perhaps, was also formed the whole planet system.

14. <u>What would happen to the Earth if the Sun ceased to extend to it its attracting hand</u>. Gravitation holds the planet near the Sun and satellites near their planets and does not allow them to escape into infinite and cold space.

If the Sun, like a rope, did not hold the Earth, then a year would not pass by before everything living and everything unprotected on it would perish; the Sun would be turned into a very bright star, whose luminous intenisty and heat would be 37 times less than that of the present Sun. In 2 - 3 years the temperature of the atmosphere and external parts of the planet would differ little from the temperature of celestial space (200 degrees below zero); subsequently the light would disappear, and — the last consolation — reminding us of the playful electric sun; there would remain an icy night with a beautiful but sad sky. Oceans would freeze, and the air would condense into liquid and would destroy man, trying to get warm in burrows as a last resort.

Everything would disperse into various directions; the planet system would not exist. If the planets with their unfortunate inhabitants had even encountered in several hundred thousand years another sun, for which, however, chances are very small — they would again immediately lose it, for which two or three years would be enough; in such a short interval of time, the pershing or smoldering life would not have time to get back on its feet.

So this is what kind of a role gravitation plays!..

It decreases rapidly with distance, as light and sound, heat, and magnetism — and by the same law.

It as though breaks apart and dissolves in space, which is expanding more and more upon leaving the source of the force.

The Earth is drawn to the Sun with a force 50,000 times less than the same Earth but lying on the very surface of the Sun; nonetheless, this force is enough to change the natural rectilinear motion of the Earth into circular motion on more exactly — elliptical.

Celestial bodies, moving very fast, cannot be retained by the Sun for a long time; it turns them from the straight path, but not for long: it picks up speed and the body passes into infinity; these bodies are comets; from them, others return back to the Sun; the path of the latter (trajectory, orbit) is an extremely stretched circle (ellipse, like a long bubble in a bad window glass).

15. Mutual attraction of stars and Milky Way. Where is there no weight? When we go away from a candle, its light weakens; the force of gravity is found in absolutely the same dependence on the distance.

Withdrawing from the candle to 10, 100 versts, we will finally lose it from sight; similar to this, withdrawing sufficiently from the source of gravitation, our sensory organs will absolutely lose the ability to determine, or at least to note, the infinitely depreciated gravity force.

Interstellar spaces, especially the space between "specks" of the Milky Way, are namely such.

Even between stars, the gravity is at least 100,000,000 times weaker than the attraction of Earth at its surface. This means that a motionless body placed there for twenty-four hours will pick up a second speed, equal to 9 millimeters, i.e., less than 1/4 vershok.

In a year this speed is not more than that which man obtains on Earth when jumping the height of a table (5/6 meter).

Between the specks of the Milky Way, or star clusters, gravitation is less than the preceding by 1,000 times; hence the conclusion that in one year man obtains there the same speed which he obtains while falling from an altitude invisible to the eye (1/1250 millimeters). The speed of stars is so great (description 10) in comparison to the influence of gravitation that their path even though curved, the curvature is quite minute. Perhaps, the stars are not in a state to emerge from their own cluster — from the sphere of attraction of their Milky Way, — however, in no way from the sphere of a neighboring star, having average distance between them. Although there are a number of "double" and even "triple" stars ("hybrid stars"), or stars revolving one around the other like the Earth around the Sun or like the Moon around the Earth, and comprising systems similar to planet systems, except that they are composed of self-illuminating members, nonetheless there are exceptions that occur thanks to the relatively negligible distance between such stars.

16. Apparent absence of gravity. There is no need to climb so far in order to see various phenomena in the absence of gravity.

We will imagine ourselves on the "minutest" planet, revolving around the Sun, anywhere between Mars and Jupiter, i.e., in the belt of asteroids or outside of it, nearer the Earth. There can be no deficiency in such planets in any case; if we do not see them in the telescope, it is only because of their smallness. Around the Sun in the planet system there is further no deficiency of planets — the pebbles, peas, and dust particles, which repeatedly intersect our atmosphere, being heated by friction against the air and gleaming like stars (aerolites, or "shooting stars"). Sometimes they touch even the hard surface of the Earth, and we collect them, preserving them in our museums.

And thus, we are on a planet several tens of meters in diameter; it is possible to disregard its gravitation, actually, for instance, 6 sagenes in diameter (12 meters) and with an density equal to average density of Earth (5.5) such a planet

reveals at its surface an attraction 1,000,000 times smaller than terrestrial attraction.

The question is: will our small weight change on this planet under the influence of gravitation of the Sun?

Sun transmits to the planet known motion; however, precisely the same motion it also imparts to our bodies; the Sun changes the motion of the planet, but in exactly the same way it also changes the motion of our bodies. Thus, what if, for instance, we did not touch its surface prior to the action of the Sun, then also after that action we will not come closer nor further from the planet. And this indicates that our relation to the planet is not changed under the influence of outside gravity force, no matter how many such forces there are and no matter whereever they would pull, if only the distance of their centers to the observed group of bodies would be great as compared to the magnitude of the group itself.

You will understand this if you will remember how the same flow of water removes a pile of chips, where as their relative position is not changed for a long time. The heap of chips is us and our planet, and the flow is the attraction of the Sun.

Hence, the apparent absence of gravity can be encountered on every little asteroid several sagenes in size. However, also the large masses, even arbitrarily huge, do not necessarily render influence on other bodies by their gravitation.

Thus, calculations show that the hollow sphere does not produce any mechanical action on bodies located inside it or on its internal surface. If our planet is an empty glass sphere containing air and plants which purify it, then we have an excellent situation for conducting all kinds of experiments. It is true, that air itself renders attraction, but it is comparatively insignificant.

Our glass sphere rotates around the Sun between orbits of Mars and Jupiter. Will this not be a little too far? Could we not create, on Earth itself or very close to it, conditions in which gravity could be as if absent? Yes, we can; only lets keep quiet till that time and let's imagine that by some miracle the

terrestrial gravity disappeared... We will describe what will occur then... Man has so related himself with his environment to such an extent that he cannot find a more suitable method for description of phenomena occurring without gravity; therefore, we will endeavor to preserve the whole situation except for a few exceptions.

III

Description of Various Phenomena Occurring Without Participation of Gravity

17. Gravity on Earth has disappeared. Gravity has disappeared on the globe: air has instantly evaporated, rivers and seas have ceased to flow, they have boiled out and are frozen; plants have dried up, animals have perished. Still more will happen, but one can't foresee all nor can one describe it.

Gravity has disappeared, but let us assume that air will remain, and neither sea nor rivers have been volatilized. To create this is fairly difficult, but to imagine everything is possible; we will assume, incidentally, that also the centrifugal force of diurnal rotation of Earth did not scatter from its surface all objects on it into various directions. For all of this the Earth does not have to turn, and air should restrain from scattering the strong crystal shell, similar to the imaginary sky of the ancients; then humidity will also be retained, — plants will not dry up, and living creatures will not die.

It is further possible to assume that the terrestrial world was turned into an empty sphere and was turned inside out: air, trees, homes, people, rivers — let us assume that all this will be inside the sphere, but outside let us assume that central masses of Earth will emerge. Here the gravity will be destroyed by natural order (description 16).

In the center of our new dwelling we will place a small sun and will take advantage of the eternal day.

One way or another, we live in an usual situation, — only gravity is lacking.

18. <u>What was in the house (subjectively)</u>. Yesterday we lay down like nothing happened, and today we awoke in a medium free from gravity.

This is how it was. I awoke with the terrible sinking of the heart which occurs during a fall from heights. I threw off the blanket and see that my bed stands like a column, but I do not roll off it. My comrade, sleeping in the same room with me, awoke also with a sinking heart, and was cold: the mattress threw him with its elasticity together with the blanket, and he was actually on the ceiling but could not cover himself on all sides and shivered from the morning freshness.

I almost did not have my blanket, somehow it stuck to the bed, and I myself hardly touched the mattress.

It seemed to me all the time that I would fall... my heart would sink... I turn around... see that everything is in its place... I calm down; doze off — again my heart sinks. Gradually the intervals between the moments of sinking were increased, and this false sensation of falling weakened. But when I got up to dress, unexpectedly and quite smoothly I flew to the opposite wall... and my heart again started to beat disturbedly... I ceased to distinguish the floor from the ceiling, top from bottom; it appeared to me that the room was turning without any sense, together with the garden and the sky which were visible from the window. Terrible confusion happened, indescribable.

I traveled through the air to all corners of the room, from the ceiling to the floor and back; I turned in space, like a clown, but not by my free will; I bumped against all objects and with all parts of me, I set everything into motion. The room floated, it rose and descended like a balloon, — it departed and then bumping against me, went onward... Everything in my head was confused and still — there was this unpleasant sinking sensation...

Wishing to get various things, to get dressed, we shifted everything, — everything flew, whirled, was knocked over on us, also against walls, and one upon the other.

In the room there flew "unmentionables" in friendly embrace with a hat, a frock-coat and scarf floated, twisting and vibrating beautifully; boots and stockings were in different places; you reach for one thing, and another will get hidden in some corner, enjoying there the solitude...

We were heading badly where it was necessary to go, and throbbed like flies against a glass tube... forgetting to hold ourselves and hold the necessary articles of clothing that were still not on us, and here, together with half pulled-on trousers, tumbled, forgetting to grab the frock-coat and attracting new problems.

Books on shelves, all sorts of trifles — it looked like everything became alive and gradually roamed around, not having, apparently, any serious intention to rest.

The room was like an aquarium with fish; it was impossible to turn in order not to touch anything; tables, chairs, easy chairs, mirrors, were suspended in air. At random everything was done in powerful evolutions in comparatively lifeless disorder, but as if pondering. Books were opened, were fluffed up and turning, as if saying, "Read us from all sides, here we come to you ourselves from sheer boredom."

When we pushed aside the annoying object dangling in our faces, getting entangled on the nose, tickling the ear, and hair, with extraordinary rage, as if being angered and aiming at us for our impudence, it flounced around like one possessed, from corner to corner, striking us and upsetting objects, causing especial disorder by its motion. Gradually it calmed down, pushed only some doll over, — well, as though saying, "Why don't you rebel"? And it rebelled.

A pocket watch, caught accidentally by a chain, dragged like a snake, indicating to us the time and in reward settled in a vest pocket.

To restore order was impossible: the more zealously we restored it, the more it was disrupted... The clock with the pendulum stood and did not work, in spite of all our efforts: our pendulum refused to swing. The water from the carafe

spilled because the carafe was knocked down and flew at first in the form of an oscillating sphere, and then broke into pieces from blows, and, at last, adhered and ran down the walls. In other rooms also everything was out of order; but since no one performed there, at least everything wasn't in crazy disorder, did not move, did not hop, did not strike. Looking closer, however, we noted a slight wandering.

In contrast to the mess in the home, the garden looked as always: the trees were green and were swinging, grass was whispering, flowers smelled fragrant, and their odor reached through the screen of the open window. I feared to remove the screen itself, so as not to lose the things which repeatedly already neared the frames which faced the garden and, as though regretting the impossibility of a further jaunt, slowly, slowly departed...

We became somewhat familiarized with the new position; I did not shriek when I was upside down, between the "sky and the Earth"; my heart did not sink; we learned to keep our place and to move in any direction.

Only we still could not manage to fly without rotation: as soon as we took off there by all means, although weakly, still we start to turn; this is terrible because it feels as though everything rotates around, and also the head spins around. It is also difficult to get rid of the thought about the unsteadiness and mobility of the house. It is difficult to convince oneself that you are the only one moving... you push yourself away and it seems that you pushed the room and it started to crawl like a light boat, to where you pushed it.

19. An unsuccessful jump, which ended safely (subjectively). Do not imagine, reader, on the basis of the preceding description, that in space, free from weight, bodies have the property to activate themselves into motion. Quite to the contrary, a body in such medium, not having motion, never receives it without the action of forces, and, on the contrary, — while in motion, preserves the latter permanently. If we had everything roam for us, it's only because in places deprived of gravity, there is no friction occurring for the most part from the weight itself, in

consequence of which the least effort is sufficient enough; an insignificant puff of air, in order to shift an object from its place, to force it to rush eternally in one direction and to rotate eternally.

It is very difficult to affix an object, without somehow accidently bumping into it. Try, for instance, to put a samovar directly on the floor! It seems that nothing could be simpler; but you won't succeed when, you yourself can't even be held back.

While you hold the samovar in your hands, — everything is excellent — it stands; but as soon as you release your hand it immediately will start very, very slowly to turn to one side — to be inclined; you look, after some five minutes; it already left the floor by a vershok and does not touch the floor... The fact is that when you took it by hand, you imparted to it some motion occurring from the involuntary and inconspicuous vibration of your hand, and after some time, manifests this motion.

If our bodies have gradually quietened down, then it is only due to resistance of air and loss of speed from the blows.

The wandering of bodies in a free medium can be compared to motion of motes in a pond. Look how restless they are, eternally stirred, eternally crawling, but in water they encounter comparatively great resistance...

From wall to wall, not without failures, we flew in a broken path around all rooms and were outside, by the doors of the porch. Here we pondered... Should we push off unevenly — we will fly into the "sky"... How will we return from there?.. We jumped into the garden, but calculated incorrectly (jumped too) and flew into the mountains, not even touching the highest trees.

In vain we extended our hands to them, so that we could hold on at least to the tops of the trees: trees left and became lower — somehow vanished. Furthermore, from moving of hands and legs (against air) I began to revolve. To me it seemed that the whole huge site, from which I departed, was turning: it was above

my head (under me was an abyss), then became a wall, then it seemed to be a mountain leading to the sky...

I — am alone; my friend lagged behind, although he shouted to me, "Now I will overtake you." I want to wait for him, to stop; I wave my hands, but uselessly...

I know that I am flying, but cannot realize this with my senses, it seems to me that I am absolutely motionless, but the Earth moves... What I feared happened: I am lifted into infinite space, to become a satellite of the Sun, in short — to become a planet...

What I long ago thought, while lying on the grass and looking into clear space, happened: "And what if I will fall into it..." And here I am falling, and oncoming air sways my clothes... Oh! But after all it should stop my planetary current...

However, an hour passes by, and I still cannot stop... I use desperate efforts, but in vain... My friend has disappeared from view.

Far off something appears... nearer and nearer... it's a barrel... it hit against me... Oh! The devil with you, what an aim! From the shock I fly to the other side... Excellent! Exactly back... here is the garden... and there is my friend, helplessly flying around... I grasp his stretched out leg and together (not especially gracefully) we discend into the shady coolness of the garden... The leaves tickle our faces... but we do not pay attention to anything and, tormented by agitations, with caution obtained from the sad experience, from tree to tree, from twig to twig, reach the arbor, lock ourselves tightly, in order not to vanish, and surrender to sleep.

If anyone saw us sleeping, they would compare us with dead bodies, floating from a puff of breeze... It is clear, one can't imagine such a soft bed, which the space is in any place, free from gravitation.

20. <u>In the garden</u>. We were sliding closely to the ground, touched the grass; like butterflies touching the flowers, we were delighted by their freshness and fragrance... like a bird we flew between shrubs and trees, reached for them, and,

turning around them several times and twirling, like birds, sitting down, after swaying on a thin pole, we remained there.

If one were not to settle down and to release an elastic trunk, turning half, or a quarter way around, then the direction of motion waved be changed, but not destroyed... It is pleasant to lie motionlessly, close to the soil: sometimes it seemed that we were immersed into extraordinarily transparent water or we were lying on a clean plate glass.

For faster motion it is convenient to push away from a tree trunk with ones legs, just like I did this (lying on the back) while bathing... there was obtained an hourly speed of 10 - 15 versts. But the resistance of air quickly weakened it, it was more practical to push away more frequently and weakly. Due to this resistance we hardly could fly, with such an initial speed, beyond the limits of the atmosphere. However, calculation shows that the motion of a body in a liquid medium (or in air) never ceases, although the speed depreciates rapidly, but not to zero; the body,moreover, in infinite time passes infinite space. Here is the flow of air, weakened terribly by the absence of weight, which could have freely carried us away.

21. What was in the city? A friend from the city strayed in or, better to say, flew into our garden, and while eating ripe apples in agitation, transmitted the following "message" about events in their place... In the city there is a terrible turmoil: horses, carriages, people, and even houses poorly fastened to their foundations, together with all contents rush through the air like dust particles and fluff... The ladies fastened their dresses at the bottom, first of all because legs were of no use, and secondly, it was convenient... Some wear masculine clothes... emancipation of a kind...

...Water coming from rivers, ponds, and wells is absorbed by the ground or flies like spheres of great size, like soap bubbles, only closer together. Such a sphere, sometimes great in size, colliding with a man who did not know how to

move out of its way, drenches him with water from head to foot, adheres to him considerably, and he, completely wet, shakes like a yard dog. Later everyone learned to travel safely, but in the beginning it was comical and bitter...

Subsoil water, of its capillarity, not restrained by gravity, was lifted to surface of the Earth, and plants, obtaining sufficient moisture, did not need rain. Actually, everywhere on my land I noticed that it was damp, as after rain, but the grass and green leaves were dry.

Everywhere they are shouts, noise; everything flies where it doesn't want to go... Everything crawls spins around, exhaling shouts of terror or astonishment... Laughter is heard — rolling, light-hearted.

In the air there are nonflying creatures: cats, insects without wings, howling dogs; and flying creatures move somehow strangely — upwards, apparently not adopted to the new conditions. A whole herd of cows bellows at the subcloud heights... And here is a company of soldiers, forgetting discipline: some stand with legs upwards, some stand sideways, some like a tilted pole; one stands on top of the head of another... and all of them, like a stack of matches scattered in disorder on an invisible cobweb.

22. In open space. We move evenly at one altitude; if we meet with a ravine, or river, the Earth is as if deepened; under you is a precipice, at whose depth there sparkle the remainders of waters which have wonderful, fantastic forms... But in vain the heart sinks: we do not fall into this precipice, but fly over it like a cloud, like a bird, or like fluffs apprehended by strong wind. Sometimes we bumped easily against a wall or hill, then we were driven back parallel to it and flew over it so inconspiculusly, as if it actually was lowered for us obligingly; on its edge we grabbed at grass, shrubs, and stones, changed our direction and again flew horizontally.

But the motion gradually weakened; it was necessary to renew its shocks and, therefore, it was inconvenient to fly high: there wasn't anything that we could be pushed away by.

The people adjusted more and more to the new conditions. The animals perished from their limited understanding, the plants were saved due to the complete absence of animals.

In the meadows of the forest we repeatedly encountered beautiful dancing games of men and women. At heights of the flying larks there resounded singing and music. The bodies posed beautifully. At times we doze off, and such dancing games bring you mentally to a dead-end, reminiscent of fairy tales, mermaids and all kinds of fiction.

Sometimes we encountered tragedy: some unfortunate ruminant, several sagenes from thick and juicy grass, was dying from hunger. Barely with intensive blows against the air and, of course, accidentally, it neared the Earth and grabbed the food, as a new, unreasonable motion withdrew the animal by its legs to heights and much further than it was earlier.

The predatory ones were still worse off (the non-flying ones, — the flying ones, although not without confusion, managed with the new conditions). Seldom, very seldom did they bump into food, nor did the food come to them... Yes, we also saw such scenes: poor sheep, chamois, deer, cow, horse, hare, not by free will, climbed into the very mouth of a bear, lion, wolf... They all bleated, neighed and, bellowed, but could not avert their inexorable fate. It also happened, however, that an animal flew within an arshin of a predator, which in spite of the most sincere desire to use the wild game, could not do this. It frequently occurred thus that the animal will strike the predator from behind and warding itself, will fly away back, not getting it in his paws. When it was possible or necessary, we saved the animal... in order to consume it ourselves.

IV

Hater of Gravity

(Somewhat humorously)

23. I had an eccentric acquaintance who hated terrestrial gravity like

horses which do not require feed and are untiring. Everyone sleeps, sits, and works where he feels like, not being in need of soil and using excellent furniture, the softness of which is not comparable to anything else. The dwellings can be constructed everywhere, at any altitude, any size which is of great value in many respects; durability is not required of them and, furthermore, they can also serve as airships, having the capacity for a lot of goods and people, if only there were place enough.

The speed of such ships, with their pointed form, reaches striking magnitude. Eternally traveling, they give their masters all goods and treasures of the globe, voyaging around would be a mere trifle...

— But you must understand that everything will turn into chaos, — I objected. — What will happen to the sea, oceans, and air?. How will a drop of rain fall and how will the field be irrigated? After all, a mass of salt water will fly into your house, into the yard, in the kitchen garden, and with what will you fence off yourself?

But the eccentric was not to be calmed down, and plugged his ears or was angered at the objections, saying that they did not want to understand him.

Then he was asked, "And where is there such a medium, and does it have any relation to us, and did he not invent the "happy Arcadia"?" He responded. "Happy Arcadia I did not invent, but such a medium exists on asteroids..."

— But there isn't any air, any atmosphere, — he was told, — and it is too far from us, if one were not to consider the distance of several hundred million versts to be small.

— First of all, the distance is nothing, because it depends upon speed and convenience of means of communication. Prior to Columbus, America was inaccessible, in spite of the comparatively small distance; now from Europe it has been reduced to 5 to 7 days; secondly, why do you think that creatures cannot live without visible breathing? Why couldn't people become adapted with the passage of time

to such a life? From teachings of certain naturalists, the atmosphere should, in time, be sucked up by Earth's crust and enter with its elements into a chemical compound, so that people and animals, whether they want to or not, are satisfied by smaller and smaller doses of oxygen... really, should everything perish; why adjust to the new life?..

Finally, gravity may be destroyed on the very Earth... Don't you know that even now it is weakened by centrifugal force and that at the equator, gravity, partly from this, is less than at the poles?..

Here he talked such nonsense that the surrounding people only waved their hands and left.

Nonetheless, much of his fantasy appealed to me because of its scientific and philosophical connotations, and the wealth of examples and thoughts stimulated by them.

For instance, he said:

— If we lived on the bottom of seas, under terrible pressure, and were only fish which were able to think, and we were told that there are water and outside of its pressure, we then would cry, "What?... Without water?.. Without pressure?.. For goodness sake! And how do they swim, how do they eat?.. They would be dried up by the sun! Oh, of course, they would be dried up by the sun!..."

We will leave alone for the time being such reasonings and many fantasies and will use them moderately and at our own disposal.

V

Can One Obtain on Earth a Medium with Gravity Different than on Earth?

24. Increase of gravity in rotating media. The increase of relative gravity in a medium of known volume is a situation which in highest measure is possible.

Imagine a huge round cup, 10 sagenes in width, and let us assume that it

rotates as a clay bowl, when the potter gives it the correct form. We will enter this cup and will take with us a ten-pound weight and spring scales.

When we stand on the very bottom, in the center of its rotation, the scales indicate 10; but should one only depart from the center, as the scales turn out to be, apparently, incorrect; the further we depart from the vertical axis of rotation, all the more they are incorrect; measure of withdrawing they show consecutively, 10 1/2, 11, 12, 13, 14... pounds; at the same time we feel somewhat uncomfortable, bloated; legs, hands, and head feel as though lead has been poured into them, the heart beats faster. As long as the cup rotates evenly, the phenomenon is observed as constant.

If cup is in the form of a paraboloid of revolution and rotates with sufficient, but not excessive speed, we will freely walk on all of its walls, observing perpendicularity to them, simular to a man walking on the globe.

On its edges we stand almost sideways, i.e., in a position, but by no means do we lie, and stand in relation to the place where we are; although, we have to admit that we stand with great difficulty, because gravity is great, as on Jupiter.

Should the cup be closed on all sides and rotate sufficiently enough (as the Earth rotates, for instance), we would have not noticed its rotation, and would only feel the increase of gravity.

Water, poured into our rotating vessel, is distributed on a curved surface, parallel to the internal surface of the vessel.* The terrestrial seas and oceans are bounded by a convex surface, here however, by a concave surface.

Phenomena in the cup are somewhat complicated with fast motions of the observer. If, however, the motions are slow or they are ordinary, but the cup is big, we

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*If, however, the vessel is of incorrect form, this will not at all cause the liquid to be bounded by the surface of the paraboloid of revolution. Assuming uniform rotation surrounding complete silence, the absence of concussions, from verticality of axis of rotation, we will obtain an excellent reflector or concave mirror. Having used Mercury, couldn't we apply it to the device of Newton's reflective telescope? This mirror can be of great size, but it is inconvenient because of its eternally horizontal position.

couldn't have distinguished this artifical weight from the same on the Sun or Jupiter: the bodies would fall as always, the pendulum would swing the same way and clock would work, the liquid would be distributed the same way, the laws of Pascal and Archimede would be the same, so on and so forth. We would observe literally the same as that which accomplished at a distance of many million versts from us on other planets, with greater gravity. This artifical gravity would also influence organisms in organisms in absolutely the same way, as real, natural gravity. Thus, it is known that the main stem of the majority of planet ascends and grows in the direction of gravity; if we covered the interior of our cup with a layer of fertitle soil and plant grass seeds, flower seeds, and trees in it, all this would rise over the entire surface of the cup in various directions, but everywhere in the direction of relative gravity i.e., normally to the walls of the cup.

Such experiments were already conducted and confirm the aforesaid; here the vessel with so: and germinating seeds would revolve by means of a water mill.

I conducted experiments with insects, where their eight by calculation was increased 300 times. Thus, they became 15 times heavier than gold of such volume; namely, I so increased weight of a cockroach, but this also made no impression on it. Hence, it is clear that the cockroach, and particularly other small insects, would not feel anything different if they were to be transferred to the Sun, assuming, of course, that it is cold and has a suitable atmosphere. It would be interesting to know what increase of gravity would not be harmful for other, bigger creatures, and especially for people? These experiments are not difficult at all. The weight of a chick I increased a few times (I do not remember how many times; five times, I think), but this did not kill it.

Here the weight is obtained as the result of two factors: gravitation of Earth and motion, but it is possible to obtain also with motion the purest mathematically identical medium of relative gravity, those phenomenon will not differ from natural gravity under any conditions at all.

For this, the medium in which we wish to obtain artifical gravity, should be given uniformly accelerated and straight motion. It is understandable that in practice such motion can continue only several seconds or — at the most, a minute.

If bodies fall rapidly to the ground, this is an indication of gravity; if however, to the contrary, the bodies are motionless, but the ground moves on them uniformly-accelerated, there occurs a phenomenon of apparent gravity which, however, resolutely does not differ from natural gravity.

It is known that the weights of Atwood's machine move uniformly-accelerated. If we ourselves would decrease to the size of a fly and were placed on these weights, we would feel during their motion either an increase of our weight, or a decrease, depending upon their motion upward or downwards. The heavier one weight is in comparison with another, the closer to zero the apparent weight of the first, and on the second it is almost doubled.

25. Examples of apparent change and even full destruction of gravity in a given medium. When you roll down from an icy and steep hill in a carriage or on skates, the direction as well as the stress of gravity (with respect to skates or carriage) is disturbed. Gravity decreases, and its direction is normal to the surface of the mountain. The steeper the hill, the weaker the relative gravity and the more body of the one who rolls will deviate from vertical, and, to the contrary, the more positioned it is, the less the gravity is changed.

When one rides from tower to tower in carts on evenly bent rails the same occurs, but with great variety: also with the increase of gravity, also with decrease of gravity, also with its complete destruction (with respect to the cart and objects in it).

All this, of course, continues for several seconds, and passengers, not being in a state to give an account to themselves of the occurring phenomena, only feel trepidation and sinking, which are so pleasant for lovers of strong sensations.

Everywhere, where there exists nonuniform or uniform, but curvilinear motion, on all such bodies (and relative to them) the gravity changes its direction and

stress. Various kinds of swings and merry-go-rounds — places of apparent change of gravity, which is also indicated by sinking, dizziness, etc.

Someone, somewhere, recommended to exploit the lovers of strong sensations with a device for special entertainment; it seems that it consisted in that a chamber with the "lovers" placed there, fell from a high tower directly into a reservoir with water, where it gradually would lose its speed and then would surface to God's world to the common pleasure of the public and the "lovers."

What do the latter experience during this fall and swift submersion into water?

Assuming that the chamber falls from an altitude of 300 meters, i.e., from the Eiffel Tower, we will find that during almost 8 seconds prior to falling into water, the passengers will be in a medium of apparent absence of gravity. This is because the gravity of Earth removes equally the chamber, and also the bodies in it, in consequence of which the relative position of these bodies among themselves and with respect to the chamber is not disturbed by gravity.

How, for instance, can a stone fall to the bottom of the chamber, if it itself falls with the same speed as the stone?...

Further, during submersion into the basin, the relative gravity in the chamber has chances to increase so much (depending upon its form) that the "lovers," from their own weight will be flattened like bugs, that have been stepped on.

I would propose another method which at the same altitude of the tower gives twice the time for observation of the space free from gravity and, furthermore, — subsequent increase of gravity occurs quite evenly and depends fully on us, and that is why perhaps such a method, under known conditions, is absolutely safe.

These are rails, having the form of a magnet with legs going upwards, or a horseshoe; the cart embraces the rail from two sides and cannot slip from it. Falling from one leg, it makes a semicircle below and rises on the other, where it is automatically delayed when it loses all its speed.

During motion to the semicircle (to the curve) the relative gravity vanishes; then, on the curve, it again appears in larger or smaller degrees depending upon

the radius of the semicircle, but is approximately constant. Upon lifting on a straight or vertical rail, it again disappears; it disappears also during backward fall, if it were not retained at altitude. In this manner the time of observation of the apparent absence of gravity is doubled. If one were to disregard the friction of the cart against the rails and the resistance of air, then it should roll (to and fro) eternally, as a pendulum. Then the observers, sitting in it, would experience alternately either the absence of gravity, or the increase of it.

Here are the results of calculations in which we removed the complicating conditions of friction against rails and resistance of air; at low speeds and altitudes they do not have great influence.

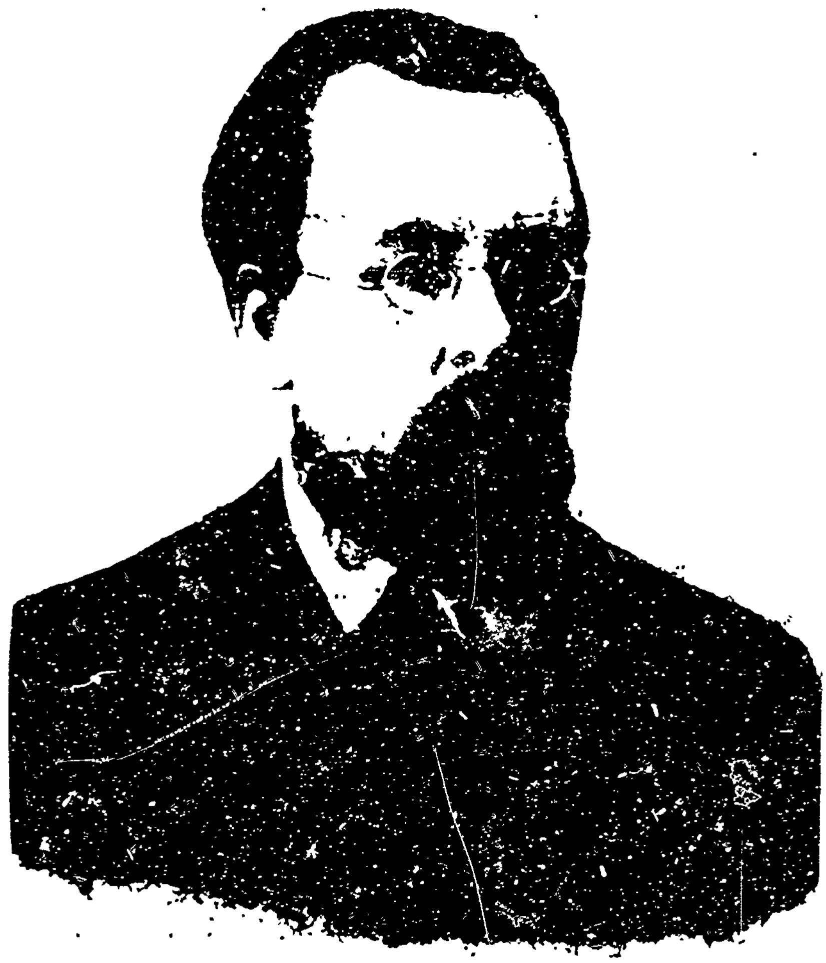
Data: Eiffel Tower is 300 meters, radius of curvature is 15 meters: Conclusions, the greatest time of space free from gravity is 15 seconds; increase of gravity during motion along the arc is 40 (a man who weighs 4 poods would weigh 160 poods, or 2 times heavier than gold of the same size as the man); time of its observation is slightly more than 1 second.

With increase of radius of arc, the standard gravity is increased by four only 10 times (40 poods per man) and will continue for 4 1/2 seconds.

If one were to use a fall four times lower, then the time of observation of apparent absence of weight will decrease only 2 times (8 seconds), but then the weight with the same arc (15 meters), will decrease 4 times, and a four-pood man will weigh 40 poods, and at a radius of 30 meters — 20 poods; such gravity, in a prone position or in water (up to the neck), man, in all probability, will endure without any harm for himself.

During still lower fall, safety is still increased, but the time of observation of interesting phenomena is excessively shorter.

When a man, rolling from an iceberg, changes his direction of motion at the bottom of it, his relative weight here, although briefly, is increased 10 - 20 times and more, depending upon the circumstances. And man, as it is known, does not suffer from this.



K. E. Tsiolkovsky, 1910.

Old house of K. E. Tsiolkovsky in Kaluga. The scientist lived in it from 1904 to 1932. Converted to a House-museum in his name.

Corner of the workshop of K. E. Tsiolkovsky on the glassed in porch of the old house. In the center is a combined carpenter's work bench, serving in case of need and as a metal-working bench. On it there stands a small crimping machine; on the left on the small table is an electrical machine.

There are conditions at which also great increase of weight can be absolutely harmless to man, — this is the location of him in the water. It would be extremely curious to make such experiments in the revolving cup (description 24).

25_1. Can the human body endure the absence of gravity? The means to protect the body from manifestation of extreme force of gravity. Something similar to the absence of gravity can be experienced also for a long time on Earth.

We will imagine a big, well illuminated reservoir with transparent water. A man, whose average density is equal to the density of water, while being immersed in it loses weight, whose action is balanced by the reverse action of water. Wearing special goggles, one can see as well in water, as in air, if the layer of water is small and is clean. It is possible also to adapt an apparatus for free breathing. But, nevertheless, the illusion will be by far not complete. It is true, that man will be in equilibrium in any place of liquid; it is possible also with a small attachment to reach and an arbitrary stable direction of his body, but the resistance of water is so huge that the motion given to the body is almost instantly lost; actually, — it is excessively slow, but then it is also inconspicuous to the eyes. Since such a position in water is absolutely harmless, one would think that the absence of gravity for an arbitrarily long time would be endured by man without bad consequences. Really, the absence of gravity destroys the weight of the column of blood and, therefore, should increase the pressure of blood in the brain; but the very same increase occurs also during submersion of the body into water; almost the same occurs also in a prone position; thus, the body does not experience anything special, upon the destruction of gravity.

The most fragile bodies, placed in liquid of equal density to them, endure without their disintegration the strongest blows by a vessel or on the vessel, if only the vessel itself were whole.* Whereas, during these blows the relative

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*Regarding the accuracy of the aforesaid, you can be convinced personally. We will take a glass of water, a hen's egg, and salt. Place the egg into the water, and add the salt to the glass until the egg starts to rise from the bottom to the

weight in the vessel, although briefly, increases several hundreds or thousands of times. It is known that all that is weak and, delicately arranged — embryos, brain — nature places into liquid or liquid surrounds it. Couldn't we also benefit by this for our various purposes?!.

26. Apparent and prolonged destruction of terrestrial gravity is practically impossible. We will offer more examples of apparent formation of a medium without gravity, but for a prolonged time.

An imaginary Earth satellite, like the Moon, but arbitrarily close to our planet only outside of the limits of its atmosphere, that is, 300 versts beyond the Earth's surface, is an example of a medium that is free from gravity with very small mass.

Why is it close to the actual Earth, while bodies on it or close to it are apparently not subjected to its action? We will explain this in description 16.

"The elbow is near, but you can't bite it." Actually, in spite of the relative proximity of such a satellite, how would one climb beyond the limits of the atmosphere to such a satellite, if even it did exist, or how could the terrestrial body be given the speed necessary for the excitation of the centrifugal force destroying the gravity of Earth, when this speed should reach upto 8 versts per second?

If it were possible to construct a train, moving on the Earth's equator with the speed of 8 versts per second, in the railroad cars of this train gravity would be destroyed by centrifugal force; but, unfortunately, air will not allow motion with such speed in any case.

[FOOTNOTE CONT'D FROM PRECEDING PAGE].

surface of the water. Then add a little water, so that the egg is in equilibrium in any place of the vessel, i.e., so that it, being in the middle does not rise upwards and does not descend to the bottom. Now strike the glass boldly against the table as strongly as the strength of the glass will permit, and from this the egg will not be agitated. Without water the egg, of course, with the weakest blows would instantly crack. These experiments are described by me in volume IV of the proceedings of the Moscow Society of Naturalists for 1891.

If the Earth would gradually increase the speed of its rotation, it at first would stretch into a flat cake on the equator, then it would burst and form, with favorable conditions, something like Saturn with its system of rings; on these rings there would be no gravity.

But this is still less conceivable than the fast train.

What remains? Should one construct high towers or launch spheres, similar to those "launched" by Jules Verne?

On the tower, as we climb up it, the gravity decreases gradually; if it is constructed on the equator of the planet and, therefore, revolves rapidly with it, gravitation still decreases not only because of withdrawal from the center of the planet, but also from centrifugal force increased proportionately to this withdrawal. Attraction decreases as the light of a lamp placed in the center of Earth, upon withdrawal from it, and the centrifugal force increases, in the opposite direction. Finally, on Earth, gravity is destroyed on top of the tower 5 1/2 radii of Earth in altitude (34 thousand versts from Earth's surface; Moon 11 times more).

During ascent on such a tower, the gravity gradually decreases, not changing direction; at a distance of 34 thousand versts it is absolutely destroyed, then high is again revealed with a force proportionate to the withdrawal from the critical point, but its direction is reverse, so that man turns with his head to the Earth, which he sees above him.

I relate several more accounts of this kind about the planets, the most distinguished ones.

1) On Mercury and in the approximation of Mars the critical point will be 6 radii of the planet, or 3 radii of the Earth.

2) On Venus — almost like on Earth.

3) On the Moon it will be 50 radii of the Moon, or 13 radii of the Earth.

4) On Jupiter — 1 1/4 radius of Jupiter (counting from surface of the planet, as in all these calculations), or 14 radii of Earth. The new satellite of Jupiter

is only 1/4 radius further of the planet.

5) On Saturn — 4/5 of its radius, or 6 radii of Earth. At this distance, or more correctly, somewhat nearer to the planet, the ring of Saturn starts.

6) On the Sun, its attraction is destroyed by centrifugal force at a distance of 26 radii of the Sun, or 2,800 radii of Earth. A tower of such an altitude constitutes nearly 1/8 of total distance from Earth to Sun.

What is the possibility of these towers on planets, it is useless to say, nonetheless, even in the planet system, this sand grain in the space of an infinite number of other similar systems, we see something similar when looking at the ring of Saturn in the telescope...

If one were to fire a bullet from a gun — a chamber with people, air, and food supplies — will this suffice for a long time! Furthermore, with dimensions of the gun even being several versts in length, there will be formed in the barrel, during motion of the bullet, such a mighty relative gravity that man, prior to take-off from the gun, would be flattened from his own weight, exceeding his ordinary weight a thousand times.

But then after getting out of the dark barrel, allowing that the traveller by some miracle survived, his weight disappears instantly, and he will find himself at a close distance from Earth, apparently outside of its influence; whether the speed of the missile here small or great is of no consequence (i.e., the gravity is being destroyed, all the same), but it should be great so that the bullet would not stop and would not tumble back to Earth, like a ball thrown upwards. So that the bullet would depart from Earth forever and would be a satellite of the Sun, there is needed a speed of 11 versts per second; so that it would depart forever from the Sun becoming a fleeting comet there is necessary a speed of not less than 27 to 30 versts per second (during firing of the bullet in the direction of annual motion of the Earth).

I imagined guns, not exceeding several versts in length, but if one were to fix them horizontally to increase their length several hundreds of times, the

enterprise will not be as comparatively thoughtless, since relative weight in the bullet will increase not very strongly and man during favorable conditions (immersed in liquid) will easily sustain it.

VI

27. Thoughts of an eccentric about the harm of air and on the possiblilty of living in a vacuum; his dream about a special race of intelligent beings living without atmosphere. My eccentric appeared to be also a hater of air.

— Air prevents fast motions, — he raved habitually. — Air destroys motion!

— Air in a medium without gravity is real punishment!

— Without air there I could fly a million versts with one thrust; with air, firstly, I am forced to renew motion by constant thrusts, expending force proportional to the passed path or time: secondly, if the speed of dissecting of air should be great then small expenditure of work with small speeds extraordinarily quickly increases and becomes an unbearable burden.

Thus, with increase of speed by 10 times, the work dissecting of air in a unit of time increases 1,000 times, and with a 100 - fold increase of speed this work increases to - 1,000,000 times. Meanwhile, in an absolute vacuum, once the speed obtained by the body, no matter how great it is, it is retained by it forever, for that not requiring any power for its expenditure.

It is true, there are forces delaying motion, besides friction of other well-known forces. This is electrical and mechanical induction. For instance, the influence of Moon produces on Earth tides and ebbs, whose phenomenon delays the daily rotation of Earth;* this is exactly what I call mechanical induction. But with ordinary conditions, its influence is quite inconspicuous.

*But perhaps, it accelerates as much due to contraction of the Earth from cooling.

— You said — he continued — that motion of an equatorial train with a speed of 8 versts per second is impossible owing to resistance of air, and for the same reason there is impossible also destruction of gravity in the coach of this train...

— I indicated — I objected — the resistance of air as one of the main causes of the impossiblility of such speeds, but this does not mean that there are not other obstacles...

— Wait, let me finish telling... imagine that on Earth there is no atmosphere and that our planet is smooth. Why doesn't the train have the speed destroying the weight due to centrifugal force?

— If we would give the train such a speed — he became more inspired, not letting us insert one word — the train itself would lose weight, would cease to press on the ground and would cease to touch it — and would rush eternally around the Earth as does the Moon, never tiring and preserving for its passengers wonderful conditions of a medium without gravity!

— All this is excellent — we said — but you exaggerated somewhat and forgot yourself; the Earth is not smooth; on it there are oceans, atmosphere — and neither people nor plants can live without them...

— I not only consider the Earth, I imply generally, planets and living creatures capable of living there. On asteroids, on the Moon, for instance, there is no air and water, their surfaces may be smooth or, at least perhaps the way is smoothed out necessary for the travel of trains with fast motions; a creature there can adjust to life in a vacuum... Don't we see on the globe everywhere life overflowing in any circumstances: also in water — sea and fresh — also in air, and in soil, and at altitudes, and in heat, and in cold, and in waterless deserts, and at depths of the seas with terrible pressure, and on mountains with comparatively low pressure!.. — You have to agree — he continued — that even if for living creatures there is needed oxygen, then also its extreme degree of rarefaction does

not play a decisive role — does not negate life. Thus, its solution in rivers is not denser than 1/140 the density of the atmosphere; and this turns out to be sufficient for sustaining life! But such a density and correspondingly small pressure is not difficult to preserve in closed and thin vessels.

— Let us imagine a glass sphere, several sagenes in diameter and supplied with a strong safety screen out of steel wire. Or let us further imagine, with relatively larger dimensions, a steel a sphere with a continuous series of apertures, closed hermetically by pure and transparent glass plates.

We will place there a little soil, plants, oxygen, carbon dioxide, nitrogen, moisture — and all conditions for existence of animals will be observed there.

This sphere rushes with all it contents in an absolute vacuum, encountering not the least resistance, as an asteroid, and as the latter, with fast motion loses relative gravity, which, therefore, cannot be smashed or crushed by its own force. The only problem is to restrain insignificant pressure of gases.

— This is too artificial and unstable — this is not actual nature...

— Yes, after all, eye-glasses are not nature but you wear them... The further man progresses, the more the natural is replaced by the artificial!..

— No! Prove that organisms are possible in a vacuum without your spheres, living there the same way freely and naturally, as fish in water.

— If you please!.. What is required for them? — Heat! It is given by the Sun; the degree of its heat does not play a great role, and, furthermore, it depends partly upon surrounding conditions. For instance, when the Sun is in the zenith above the summits of the Himalayas, these summits are nearer to the Sun than their base; the temperature, conversely, at altitudes is lower than at ocean level.

The same body is heated to extraordinarily different degree, depending on how we will position it in relative to the Sun and what color it is; here, however, the atmosphere plays no part.

— What else is necessary for animals? — Motion! It is given by the same Sun, because the energy of its beams is not small; each square meter of surface

normal to their direction and at a distance of the Earth, gets 2 - 3 steam horse-power, replacing the continuous work of 20 - 30 men (for 1 square arshin — 10 people); if one were to use only 1/20 of this physical work, transforming it into mechanical work by means of special motors (which can be done on Earth), even then there would be enough of it for one man-like creature; and in a medium without gravity it (the work) too is necessary.

— Also the animal is in need of oxygen and food for processes of thinking, growth and muscular activity, — he carried on his line of thinking, — oxygen can be formed by chemical work of solar rays in the actual body of the animal or in its special appendages as it forms air from carbon dioxide in green parts of a plant.

Carbon dioxide of an animal, instead of being dispersed into the atmosphere, will remain in the animal and serve as material for formation of oxygen and new reserves of carbon.

Chemical activity of Sun, in general, as also in plants, will be manifold and complicated, furnishing the animal all that is necessary for its life.

Thus, in these surprising creatures the animal is combined into one whole with the plants, and therefore, such a creature may be called an animal-plant. As it is known, something similar exists also in the world of terrestrial organisms.*

— But digestive, respiratory and other secretions of our imaginary animal-plant are not lost, and are completely processed with the activity of the sunlight into food and oxygen, which again proceed for feeding the creatures, accomplishing eternal rotation and never being exhausted.

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*Green grains of chlorophyll are found in radiolaria; radiolaria — are small unicellular animals, found in large quantity on the surface of the sea; chlorophyll is found also in comparatively big animals: in hydra, sponge, medusa (having the form of a bell), actinium and others. Role of chlorophyll: carbon dioxide, secreted by the animal is processed by means of solar rays into oxygen and carbon necessary for eating and breathing. Such a creature theoretically can manage without external oxygen and external food. Scientists think that the green (pigments) of these creatures represents quite a special organism, so that in this case they see only an example of close cohabitation, or symbiosis.

Here there is nothing impossible. Don't we see the same, only in a larger scale, on the surface of the globe. Don't the same materials serve eternally for the life process of plants, animals, and man himself?

The Sun works, but the material all the same is not exhausted. Why do you want to allow to exist in a small form that which already exists in a larger form?..

— We allow! Do not rave, only explain how your creatures will not wither as mummies...

— This is simple: their skin is covered with a glass-like layer, comparatively soft and thin, but absolutely impenetrable for gases, liquids and other volatile bodies and, therefore, protecting animals from any material losses.

There are no external apertures in their bodies; circulation, of gases, liquids, and dissolved solid bodies — all this is accomplished inside of the animal creature, and not by means of an external medium. The surface of the body with small wing-shaped appendages, illuminated by the Sun, serves as a laboratory for preparation of force and life. If in a medium of gravity such appendages cannot be burdensome, then in spàce, free from it, they are not noticeable even on a surface of several thousand square meters...

— Stop! And how will they, your animal-plants, communicate with one another, exchange ideas? After all, neither one transmits sound vibrations.

— Firstly, — he was not confused, — sound vibrations can be transmitted from one creature to another by a conductor, like wire, and even weakening much less from distance than during their motion in a medium of liquid or gaseous form; secondly, do we exchange thoughts only by means of sound, voice? What about books, letters?. Something similar, but much more perfect and natural serves also for this communication; on one of the visible parts of the body through its transparent cover, as in chamber obscura, play a number of living pictures, following the course of thoughts of the creature and expressing them exactly; this depends upon

the influx of subcutaneous liquids of varied colors in extraordinarily thin vessels, which are the ones that trace the number of fast changing and easily intelligible pictures.

VII

In the Belt of Asteroids

(From fantastic stories of an eccentric)

28. How I got on an asteroid. Around the Sun, besides eight big planets with their satellites and asteroids, also quite big and traveling between orbits of Mars and Jupiter, there is a mass of planets so small that with such dimensions the telescope does not pick them up.

The certainty of their existence comes from the following: no one doubts the existence of the great number of stones (aerolites), circling as also the planets, around the Sun; part of them touch the Earth and drop on it; another part, according to an assumption, loses speed from resistance of ether and excited motion of induction, and drops on the Sun, supporting somewhat its glow. If there are celestial bodies small and big, why wouldn't there be intermediate ones?*

I was on asteroids and on still smaller planets and saw life there. Oh, this wonderful country! <...> There were found wise creatures, which <...> surrounded me with cares, gave me artificial atmosphere closed in a spherical device, partly out of glass, in which there were plants with excellent ripening fruits, excellently quenching hunger, and thirst.

*When our eccentric expressed this thought, there were not yet discovered extraordinarily little planets — up to 6 versts in diameter. Thus, this discovery was anticipated by him. When our instruments and methods will be improved, then, without doubt, there will be discovered still more small planets — actual celestial Liliputians.

But that's not enough; when I wanted to see their life, they covered my body tightly, without disturbance to its forms and freedom of motions, with a special, comparatively thin shell protecting it from dangerous absence of atmospheric pressure; they supplied me with vessels containing oxygen and various other apparatuses making contact with my body and replacing, for a certain time, air, and food. These apparatuses owing to almost full absence of gravity would not have been burdensome for me, even if they were 1,000 times more massive.

Thus, I emerged from my dwelling and saw everything.

They were indifferent — whether to live in atmosphere or without it, because gases and in general, all outside bodies could not penetrate through their skin; the layer of atmosphere only somewhat delayed their feeding by solar beams...

Infinitely complicated, extensive, and of various constructions, mysterious occurrences, and mass of phenomena, unsolved by me, — all this I leave out and will describe only what strikes the eyes and is accessible to our human mind...

When I became accustomed to them and learned their visual language (for they adjusted a special mechanism for "picture" expression of my thoughts), I conversed with them at length...

I will not talk about the shapes of their bodies, because the idea about beauty even for one breed of the two-legged is extremely subjective; in spite of this, I can say, that even to me — a human — their form appeared elegant to the highest degree...

Is it necessary to recall that from asteroids the Sun seems quite little and gleams and heats 3, 4, 5... even 20 times weaker than on Earth. Asteroids close to Mars receive 1/3 of what we do, but the further away from it, the less light and heat the Sun gives them. Jupiter's luminary force decreases about 25 times, and it seems as a bright voltaic arc, almost a star.*

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*And the force of also this light is at least 20 thousand times stronger than our lunar light, during its most favorable conditions.

Therefore, judging where I stayed, I required more or less protection from cold. Inhabitants of that place, excessively remote from the Sun, had cold blood, like our fish and insects, and were made from substances, which were hard to freeze.

29. <u>My conversation with the natives</u>.

— Where do you come from?..

— We migrated from other large planets.

— How did you get here and how do you live here in a vacuum, when your bodies were adjusted to life in atmosphere?

— How we got here — this I cannot explain to you, it is complicated to such a degree; regarding, however, the atmosphere, our bodies were converted gradually and adjusted to life in a vacuum, as you have water animals which gradually turned into land animals and nonflying ones into flying ones. In general, at first on the planets there appeared water animals, then the ones living in air and, finally, in a vacuum...

— <...> Please tell me how are you fed?

— <...> We are fed and developed like plants — by the action of solar beams.

— <...> Nevertheless, I do not understand... Plants are fed by moisture from Earth and gases from air, whose energy of solar beams alters into plant tissue...

— Do you see the green appendages of our bodies looking like beautiful emerald wings? — They contain grains of chlorophyll, similar to that which colors the leaves their characteristic color; some of your animals also have in their bodies such grains... Wings, owing to their glass-like shell, do not release anything outside; however, freely, almost without loss, they let through the light of solar beams. These beams decompose carbon dioxide dissolved in juices which flow through our wings like blood of your body, and accomplish a thousand other chemical works, as a result of which there are obtained various gases, liquids, and solids. This and that, and a third, enter here partly into a physical, and partly into a chemical bond with other compounded parts of juices, forming liquid bodies, i.e., enriching

the juices with new substances. Enriched by them, these juices deliver each moment to our body all that is necessary for feeding; oxygen in weak chemical compound, hydrocarbons and nitrous substances. Similar to this, does the Sun also to your plants <...>.

— But, tell me, please, how do you with such a small surface of wings, so to say, with such a small field, get from it without even any fertilizer, so much, while a human needs for sustenance on Earth several dessiatines, that is, a thousand times more?

— It's so, — one of the natives said: — energy of solar beams in vacuum is unusually strong; furthermore, a more significant part of it (1/6) we turn into potential chemical energy, more than you do on your planet by means of your plants — and it fully suffices us for supporting the processes of life. After all, it is known to you that a square meter of surface illuminated by beams of Sun normal to it, produces work equivalent to almost 3 horsepower; but we are further from the Sun and, therefore, receive from it 3 - 4 times less energy. Thus, with total surface of our wings less than, one sagene (3 - 4 square meters) we have one day's work, equal to potential energy of 5 kilograms of the purest carbon, assuming that it during its liberation burns into oxygen; a great part (5/6) of this energy heats our body and the remaining part (1/6) goes for the formation of food. It's energy corresponds to energy of more than 2 pounds of carbon. Very much food is necessary in its ordinary form, so that it would liberate such energy (8 pounds of bread or 10 pounds of meat*). It is clear that after that we cannot be hungry.

— What? Don't you really ever experience the unpleasant sensations of hunger, thirst, in digestion?..

— Never. We have such a regulator which shows that it is time to turn our wings to the Sun <...>. When the danger of exhaustion creeps up, the regulator

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*Lebon's physiology. "Feeding and its methods."

solicitously indicates this circumstance. However, in this medium where we live there are no clouds and we are fed freely.

— So that's why you have such beautiful wings: they turn out to be your garden, kitchen garden, field, cattle yard, etc., because they deliver all that is necessary for the table: and I earlier thought that you use them to fly...

— We can fly also without wings; in a vacuum, wings for your type of ordinary flying are useless. Do the flies fly under the bell of a pneumatic pump, when the air is pumped out of it?

30. Further discussion. I was surprised by these creatures by their peculiarities: they do not drink, do not eat <...>, it seems that they are not ill and do not die. And all — with a physical shell! Here are some more of our reasonings to these things.

Do you ever get sick? — I asked once.

— Very rarely: one in a thousand every 100,000 years will get sick.

— Do you live that long?

— We live indefinitely, like your plants. There occur deaths with unfavorable coincidence of conditions, but very seldom; even fewer (deaths) from illness.

— How do you explain such a duration of life, almost immortality?

You have certain trees living for a millenium, in spite of the fact that they are constantly gnawed by illness, conquered by parasites, tumbled, by winds and gravity — and the stronger the more massive they are, more older. We are insured against this even more so... Why shouldn't we live for a long time?! For this longevity we are obliged to the cleanness of our bodies, not having any infectious beginnings: various cocci, bacilli, fungi, which swarm your unfortunate body under constant threat of destruction; for this longevity we are obliged to the complete insulation of our body from harmful elements owing to the surrounding absolute vacuum and impenetrability of our skin; for this longevity we are obliged to the wonderful arrangement of our body which has organs, regarding which you —

inhabitants of Earth — have no idea... We have special regulators of lives, which stop the body from ageing, weakening, in general, from harming itself.

— Partly you already penetrated into basic causes of death... Your experiments with generation of Infusorias* proved that multiplying by gemmation (i.e., consecutive division of infusoria into two individuals) exhausts their numerous posterity more and more. Namely, in such a way: the cells of your terrestrial body are exhausted: at first there occurs <...> increase of its volume — and the body grows; then the speed of growth is delayed more and more, because although the number of cells increases its volume, due to degeneration, decreases more and more; there comes a moment when the size of the body ceases increase; this would not be so bad, if the quality of the cell (and various tissues of the body consisting of them) did not worsen with each new generation of born cells; old age sets in, the body reduces, its useful tissues are replaced by fat, the walls of vessels through which flow juices of your body weaken, burst under the pressure of blood in various places of the body causing various illnesses and death. This death is natural, "happy" — from old age...

However, our tissue has the possibility of joining with other tissue and to be multiplied by gemmation <...>. This is the merging of two cells into one, as a consequence of which the weakening tissues are renovated and become young and strong <...>; the regulators do not let them, and they let them also increase to a certain limit; its over all size is not changed because the quantity of material of each individual is unchangeable...

— Yes, we see, — said these happy creations, — that you cease to understand us. We will try to explain to you from another point of view the possibility of extraordinary longevity and even physical immortality. Take a glance at your

*Probably, with colonies of Stylonychia.

humanity as a whole. In mass is it not immortal?. Does this whole die, and even if it dies, then does the continuation its life have definite boundaries? Who will say how many thousand or million years it will live?

Imagine humanity as a single existence, like one of us, and make a comparison; the similarity will be striking: your people are various cells of our one body; your instincts, your love and, probably, your mind are regulators supporting the existence of one whole and which do not let it (the body) age and die; if one were for comparison to take your whole organic world, with atmosphere and soil, the similarity will be still more striking: don't you live by the same quantity of substance belonging to your planet like each of our bodies? In the final analysis doesn't the Sun nourish you, just like us? From without, from another world (perhaps another planet), is not this great (although pitiful) organic body supplied with water and food? Maybe, you get a servant, money, special air?.. Nothing is given and, nevertheless, everything suffices and cannot suffice as long as the Sun shines and as long as the dimension of the "great body" does not increase unnecessarily as regards to inorganic matter. And these regulators, preventing its excessive growth, you can easily imagine yourself... <...>.

— Our body, — said the natives, — depicts in a small way the organic life of Earth <...>. Thus also you — people — will be happy, and your generation will not die out with wisdom on your part.

— This is true, humanity does not die and lives as one of your surprising existences, — it is immortal, — I noted. — But show me an example of individual uncertainty of life on Earth...

— I can, I can, — interrupted one of my conversationalists. — You have Infusoria, and life in each of them consists in the fact that it separates from itself that which is similar to it — one after another, in consequence of which (actually, not from this, but the details will go too deep) weakens, degenerates, decreases, and after several hundreds of births diminishes to a point where it

becomes unrecognizable, and it dies. But to this dying there approaches another, matching individual, which merges with it into one whole... and after that — a miracle! — it becomes younger, revives, starts to grow fast, attains normal growth, again is multiplied, etc.

— Yes, yes. Something similar to this I read,* but you, one may see, know this better than me... <...>.

— Are there many of you? — I inquired.

— Solar system, i.e., actually the Sun, theoretically can support energy of life 3×10^{23} of existence, similar to ours, this number is 15×10^{13} times more than the number of inhabitants on your globe, considering it to be 2 billion...

— Permit me! — I interrupted impolitely. — From where do you know various details about Earth which surprised me already more than once?

— Well, here I talk with you... Why you think that we did not talk earlier with the same inhabitants of the Earth?.. Besides, if you saw our telescopes, our astronomical apparatuses...

— I understand... You say: many times greater than the population of the globe... This is such a colossal number!.. How could one have a more tangible concept?

— Thus, imagine a cubic box 25 sagenes in height (the size of the belfry of Ivan the Great), filled with poppy grain, each of which is not more than 1/2 line thick, imagine further that each such granule is the globe with all its intelligent inhabitants; then you will have a clear idea about how many creatures can be fed by the Sun. Actually, it sustains 1,000 times less, but not because it cannot feed more... It actual population, according to our conditional terminology, will be expressed by a box with poppy grain 2 1/2 sagenes in height.

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*Mopa and Del'feb. The first made experiments with colony of Stylonychia, the second offered explanation of first results obtained.

FIRST LINE

— We, — continued the inhabitant of the asteroid, — belong to a group of planetoids that travels between orbits of Mars and Jupiter, and are quite small — about the size of a poppy. (Do not forget: each grain is the globe with its inhabitants!)

— Well, pardon me, I do not agree that there are not many of you... I even do not understand where you fit. The surface of asteroids known to us is positively insignificant.

— We do not need the surface of planets: there is enough outer space, sunlight and material which we find in surplus, while excavating and smashing asteroids...

....<...>

31. <u>The planet from which one is liberated by one good jump</u>. We are on an asteroid, which is not visible from Earth in the best telescopes since its diameter is not more than 6 kilometers.* The gravity here is so weak that it is nothing to exert oneself, to jump more actively, — and we will eternally depart from it and never will approach it; we are liberated from the force of its gravitation with one good jump, which would lift us from the surface of the Earth only 4 feet — not more (1 1/4 meters).

Only the Sun will deviate our direct path and will force us to rotate around it like a true planet; due to this, after a certain comparatively prolonged time we can again be close to the asteroid which we left behind departing from it circularly and catching up to it from behind.

I ask you not to consider our asteroid as very little; its circumference is close to 17 1/2 kilometers, surface is almost 10,000 hectares (dessiatines), size is 92 cubic kilometers, and its mass is 6,000 times more than the mass of the whole <...> globe.

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*Such planetoids are perceived with extraordinary difficulty and only in the most gigantic telescopes. Easiest of all they are discovered with the help of photography. Thus, with certainty there is confirmed the discovery of planetoids: Agata, Filagoria, and Erigona. The first of them has a diameter not exceeding ~~6~~ - 7 versts.

The comparative surface of this asteroid is indeed tiny: on it there can settle not more than 3,000* terrestrial inhabitants with their wasteful economy <...>.

Here the gravity is 2,250 times less than on the surface of Earth. This means that you will carry here 2,250 poods with the same ease as on Earth 1 pood; weight of your own body you do not feel because you are drawn to the ground with a force of 7 zolotniks, terrestrial measure; a massive cast-iron cube one sagene in weight, placed on your head, produces pressure as a basket with bread weighing less than one pood; weight of a barrel with water gives the impression of weight of a glass of wine, a person on the shoulders is like a doll weighing 7 zolotniks, 2,250 persons is like one man, even less, since on Earth there is still added ones own burdensome weight, here it is not noticeable.

You stand on the surface of the asteroid firmly; by terrestrial (concept), but your least movement raises you, like a fluff, into air. The effort needed in order to jump on a terrestrial threshold 2 vershoks (10 centimeters) in height, raises you here to a height of 120 sagenes, i.e., somewhat lower than the Eiffel Tower. Weight is so scanty that from heights of half a sagene you will drop for 22 seconds — almost half a minute!

If on purpose you will want to learn and will want to tumble on the ground, similar to a sawed off tree, then you will wait for the termination of this pleasure several minutes and will, of course, not feel anything. If you will bend your legs to sit down, your legs will hang in space without support for 10 seconds, during which time you can light up a cigarette (it's a pity that absence of air will not permit this!). If you, while lying, move, stretch, sneeze, or yawn, you will immediately soar upwards at least an arshin, well, as if a feather which the breeze blew, — lifted it, carried a bit and dropped again. You can lie and stand on sharp stones: you will not slice the body, your sides will not be numb. If you forget yourself and jump up fast, as you jump (on Earth) from the grass toward an

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*From the Sun the planet is further than the Earth and therefore, the energy of beams the body is 3 times less.

approaching lady, you will instantly fly into space several hundred sagenes and will travel at least six minutes, leaving the poor lady (although imaginary) in complete bewilderment. You rise for about three minutes, and descend in the same amount of time — somewhere about 100 sagenes from the ill-fated individual.

Don't throw small things around — they fly away forever; however, also heavy stones are not difficult to throw as when they become aerolites, they disappear forever.

The terrestrial second hand, 1 1/2 arshins in length, moved here 47 times slower, and the clock, instead of, for instance, showing 1 hour 34 minutes, showed 2 minutes: time went by as if 47 times slower. The local second hand is so short (less than 1/2 millimeter) that it cannot be seen. Pocket watches acted properly (i.e., their movement almost does not depend upon gravity).

To run on the planet and even to walk is very uncomfortable, at the least such attempt you fly away upwards. However, it is possible to run with gigantic steps, each several sagenes, however, extremely daintily. Slightly more — and you will start to tumble in space from the first step, so that the next step will be taken not with your legs, but with your head, hands, sideways, any which way. Uncomfortable, uncomfortable! — You should experience it yourself.

If you want to travel, better to say, to fly around the planet on various meridians and inspect its surface, then it is better to proceed thusly: push away with your legs in a prone position and in horizontal direction from any large stone or from a ridge of the planet. Then you will fly as a fish in water, — as if you are floating: on your side, stomach, or on your back. If you push yourself away weakly, then, having flown for several hundreds of sagenes or more, you will approach the ground and will scrape it slightly; here you try to still push away horizontally from some ridge from the ground — and thusly 5 - 10 times until you will completely cease to touch it; this will signify that centrifugal force overpowered the weight of the planet. You become its satellite, its Moon, and cease to sense the influence of gravity; you are in a medium of its apparent absence.

Do not imagine that there is needed high speed! One jump in horizontal direction is enough, and the effort necessary for that is exactly twice less than for complete removal from the planet; hence, it is equivalent to a terrestrial jump to a height of 14 vershoks (5/8 meter). And the best thing to do is to obtain immediately the necessary speed (3.6 meters per second), pushing away stronger like you do this in the terrestrial bathhouse, pushing away from it with your legs.

I will note that during any kind of jumps and flights (even on Earth, not counting air), until you touch the ground, you are also in medium of visible absence of gravity, just as during a journey around the planet. This journey is accomplished without any expenditure of forces (besides simultaneous expenditure, i.e., jump during 1 hour 24 minutes at speeds of 3.6 meters per second). To move faster is impossible, because in the reverse case you will depart from the planet and at speeds of 1 1/2 times larger (5 meters per second, 17 versts per hour) will depart from it irrevocably.

If the planet should revolve, the described phenomena would be complicated.

Although with this round-the-world journey no efforts are required — travel even trillions of versts, but what is not good is the fact that the speed (17 versts per hour) is small. It is true, constructing the train with wheels upwards, similar to the ceiling reflected in a mirror, we can move with any speed since the centrifugal force will be restrained by rails. Such a train, moving 47 times faster (550 versts per hour), bears an equal centrifugal force but reverse to terrestrial gravity. A passenger, one could say; drops on Earth from the clouds; with speed 2 1/2 times less, the gravity is the same as on the Moon. Formation of gravity, it is understandable, increases friction and hinders the progress of the train.

Only part of the multimillion population of the planet lives on it; the majority of it, in pursuit of light and shelter, form around it — together with their machines, apparatuses, and structures — moving in the form of a ring, like the ring of Saturn, only comparatively larger. This living ring is located in a plane,

perpendicular to direction of beams of sunlight and therefore, it is never deprived of its invigorating force; by measure of the planet's rotation around the Sun the movement of the ring is artificially changed, and its "face" continues to look at the celestial body; the speeds of elements of the ring are so insignificant that the change of direction of its plane can be organized not only once a year, but also 100 times a day.

The diameter of the ring is 10 times greater than the diameter of the planet and therefore, the inhabitants of the first obtain 100 times more solar energy than the inhabitants of their own planet. Thus, the population of the ring is nearly 800 million individuals.

I was on their ring, flying from one of its parts to the other, and was pushed up higher and higher. It always seemed to me that the planet was rotating, we all were standing and moving only upon desire.

The speed of the parts of the ring was much less the further they were from the planet; on the outskirts it did not exceed 3 1/2 versts per hour (1.12 meters per second), when below, at the very surface of the planet, it was 3 1/3 times greater (3.6 meters per second).

With me traveled also my dwelling and all my home furniture arranged for me by the inhabitants of the asteroid. So I always could, when I wanted, use the atmosphere and everything that I had become accustomed to. And when I was bored — I veiled myself in my "skin," fastened all the munitions necessary for life in a vacuum, and strolled in it as if nothing ever happened.

32. Asteroid with diameter 10 times larger. Here is an asteroid, whose diameter is equal to 56 kilometers,* circumference — 176, surface — 9,856 square

*Certain asteroids are smaller, others larger. Of the first there are nearly 220, of the latter — 130. Here for instance, are diameters of asteroids in kilometers, assuming that they have spherical form: Agata — 7, Gestia — 25, Atalanta — 30, Virginia — 32, Levkoteya — 37, Femida — 52, Polymniya, Fokeya, Parfenopa, Pomona — all close to 60, Evterpa, Lutetsia, Talia, Proserpina — in all around 67, etc. then there is a number of small planets increasing comparatively evenly. Judging by the smoothness of this number upwards, one can think that it also stretches as evenly downwards — invisible to asteroids because of their

kilometers. Since the planet is near to the described one, it uses the same energy of beams of the Sun; however, it is able to feed, on its surface, nearly 800 million inhabitants. It's volume is 1,000 times greater than the volume of the preceding planet. The planet regardless of what you say, is solid. A jump lifts you up very little — some 130 sagenes (281 meters). To jump over a belfry or river, of course, is not difficult. The gravity, nevertheless, lets itself be known: your body, expressing in terrestrial terms, weighs almost a pound; a forty-pail barrel isn't as light as a glass with wine but like 2 whole damasks; a bucket with water presses a pound with the force of our weight.

The planet is solid enough and it is easier to run on it than on the preceding one; only do not hurry: with the least hurry you will start to tumble.

A stone, thrown with the speed of 50 meters per second, leaves the planet forever; on Earth a stone with such a vertical velocity rises to heights of 125 meters, or 60 sagenes; therefore, not only bullets and cannons, but also a child's bow launch an arrow, which would leave the planet. A stone, shot by a sling or by some other simple way, easily obtains the proper speed to leave the planet.

A train, having a speed of 36 meters per second (126 kilometers per hour), loses due to centrifugal force its own weight; such speed on the planet, at good traveling distance, is a complete trifle. Actually, there is no air, gravity is 225 times weaker than on Earth and, therefore, all kinds of friction decrease as much. And besides, at this speed of 120 versts, which sometimes is the speed of terrestrial locomotives, gravity, and consequently also friction, finally disappear; the train is raised upwards and runs eternally without expenditure of forces; if at the very beginning it is easy to run, then later it is still easier, because its lesser weight with increase of speed decreases still more, until it descends to zero.

[FOOTNOTE CONT'D FROM PRECEDING PAGE].

smallness. Their masses in general are unknown; their form is very irregular which is not only allowed by the theory of gravitation, but also directly follows from the extraordinary changeability of their brightness, or sunlight reflected by them.

On this planet it would have been possible, on a very smooth road, to ride also on bicycles, adjusting them somewhat to little gravity; but, with zeal, they will leave the planet, and you, rotating together with your container, will fly away into space.

For inhabitants of small planets there are special methods and devices — for obtaining speed, for stopping, and for protection from tumbling.

Around this planet, the same way exactly as also around smaller planets, there rotates a living ring, obtaining energy from the Sun, sufficient for supporting the existence of 20 billion inhabitants. Its population exceeds the population of the planet 25 times, but the surface only 6 times. The surface of the ring is also always turned "facing" the Sun, and its elements, this means, change their motion by measure of their rotation around the star. Diameter of the disk is 5 times larger than the diameter of the planet; its inhabitants are in constant contact with inhabitants of the planet and in this manner.

Around one of the meridians of the planet there is arranged a smooth path and on it — which embraces the planet and its crawling belt; this is a long ring-shaped platform on a great number of wheels; by means of solar motors by a continuous and tireless band it moves around the planet with a speed of 4 meters per second. On this platform by the same method moves another such platform, but smaller and lighter; on the other — a third, etc.; in all there are 9 of them; in this way the last ring platform has a speed of 36 meters, which it also loses its gravity. There is no need to be surprised by the possibility of these multistory trains: all of them weigh 45 times less than one of them (average by mass) placed on Earth.

The described system is good for inhabitants because it always ensures them a convenient communication of ring (or disk) with the planet. If, for instance, I want to head for the ring and lose gravity there, for that I stand near the first platform on the planet, like you do for a passing horsecar, in order to jump on it while it is running. Here there are attachments facilitating this similar matter.

But one can get along without them: run alongside with the platform, until you overtake it: 4 meters per second, or 14.4 kilometers per hour on a small planet is not difficult to conquer (also on Earth it is possible to run with such speed); then you will jump on first platform without a push from this one the same way to the second one; the same you will also get to the last one, where you will be free from gravity.

33. Asteroid with diameter even 10 times larger. Its diameter is equal to 560 kilometers,* i.e., it is only 6 times less than the lunar diameter; as you can see, this is already a completely solid planet. Gravity on it is 22 1/2 times less than terrestrial gravity. Man will jump only 10 sagenes; hence, he will jump over a healthy birch, five-story house, ditch, brook, 40 sagenes in width. A four-pood subject here weighs as much as on Earth weighs a seven-pound piglet. A man with ordinary strength without tension carries on shoulders, head, hands, where it is comfortable a whole crowd of 22 individuals who are similar to him. The strength of materials with respect to gravity here also is very great. For instance, man swings on a swing, whose rope is somewhat thicker than severe threads. A structure, of identical construction as terrestrial, is 22 times higher. You could construct a tower 300 meters in height, and here it could have been 6 versts (6.6 kilometers). You cannot throw a stone by hand, so that it would fly away to infinity or revolve around the planet like a satellite. But gun shells fly away completely, and bullets, losing gravity, revolve around the planet not falling on it. A train, in order to destroy the attraction of centrifugal force, should move with a speed of 360 meters per second, or 1,280 kilometers per hour.

The question is, can there be such a speed, which exceeds 10 times the speed of the fastest terrestrial locomotives?

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*Asteroids known to me are less in dimensions, namely: Vesta — 435 kilometers, Tserera — 367, Pallada — 255, Evnomiya — 187, Yunona — 172, etc. How could have our eccentric been on a planet of 600 kilometers and, furthermore, with a ring, which exceeds the planet greatly? Perhaps he mixed up our Sun with some other Sun? In our planet system such an asteroid could not have been missed by astronomers.

The air with such speed of motion is the main obstacle; but there are no gases here; gravity is 22 times weaker, friction the same amount of times less, and speed, therefore, may be at least 5 times greater, i.e., 640 kilometers per hour. With this speed the centrifugal force is only 1/4 of gravity, and this means, it will not be destroyed. Decrease of gravity, nevertheless will still increase the speed of train, but it is possible to doubt that it will attain the proper degree.

However, the inhabitants of asteroid attain necessary speed extraordinarily easy by methods already described by me: by means of multistory continuous ring-shaped trains. The forces setting them into motion are solar motors.

What kind of a motor — I will now explain. First of all, please note that the inhabitants of asteroid attained great success in the production of extraordinarily strong metallic vessels, absolutely closed, but able to change their size, well, for instance, like a bellows or concertina.

Now imagine that the vessel, filled once and for all by vapors of approaching liquid, is half black on one side which is instantly heated by the Sun, the other side is shining, silver colored. When it is turned to the Sun with the black half, the temperature of vapors and their elasticity attains highest magnitude, when the light one — the lowest. Hence it is clear that if the vessel rotates (which it can do by itself by inertia), turning to the Sun first with the dark half, then with the brilliant half, the walls of the vessel start to come closer and to recess with known force, which is utilized by the natives with simple adaptations. Thus, they process 1/3 of solar energy into mechanical energy. This is a simple system, but they have masses of others, which I will not undertake to relate.

With the use of square meter of solar surface at distance twice larger than distance of Earth from Sun (as on our planet), there is obtained work equal to 1/3 horsepower, i.e., work of three good workers.

Such motors, working eternally, everywhere, at all heights, do not have need of anything except the Sun. The inhabitants of the asteroids have them everywhere,

all possible devices and applications, they follow the natives like humble animals, always offering their services and never tiring.

These are the kind of motors which set the multistory trains into proper motion.

The number of trains, or stories, is not great — 10 in all, but the difference of their speeds is much greater than for the preceding asteroid. Namely, 36 meters. To get from one train to the other without special attachments there available is very difficult. The arrangement is such: on each train and on the actual planet there is still another band of rails with light weight carts in various places. At first, while it is still not linked, the cart, together with the rails, stands, or moves like that object, on which it is based, but should one only create a light friction between it and against the side of the moving train, it starts to move at the same level with the latter. Thus, I enter into the first motionless cart and connect it by light friction (by means of pressure) with the first train; in several minutes I am already flying at the level with it with speed of 128 kilometers per hour. Then from the cart I change to the train fastened to it from which I unhitch it, and it rolls to a stop. From the first train I change calmly to a relatively motionless cart of another stage, connect it by friction (by means of pressure) with the other train, obtain its doubled speed and rise thus higher and higher, obtaining even greater and higher speed, while in the last train it will not balance even gravity itself.

Then already I freely head for these or other parts of the ring, a thousand versts in height, as in a medium free from gravity.

In all, the 10 trains (during motion) weigh four times less than one of them on Earth.

34. <u>On asteroid rings</u>.* I will describe somemore of what I experienced a great number of times on the ring, but what I have until now not related; this is

*In Pallas and Ceres Shreter noticed atmospheres of huge height, exceeding diameters of planet by 3 times. Didn't he see the asteroid rings, composed of a

a more exact review of phenomena in a medium of apparent absence of gravity; on rings for the first time I observed with all details these phenomena.

Here I am in a splendid palace surrounded by my tall friends who propose to perform various experiments on me. Thus, they place me in the middle of a chamber and situate me absolutely motionless. Do not think that this is easy, the contrary, this is just as difficult as for you to establish equilibrium with a chair on two legs or stick with a sharp point. For a long time they bustled, using all kinds of cunning methods, before they attained my full physical calmness. Earlier I do not remember if I ever was so absolutely motionless in a medium without gravity: I was constantly crawling somewhere, and if I would stop against a barrier, I would rebound as a ball, and again the same, only in another direction; if, however, attached, although the movements become limited, but again, apparently they are inevitable; you rock like the float of fisherman. Thus, obtaining my equilibrium, they asked me to approach them. I start zealously to move my legs, swaying my arms, but I do not at all reach my goal. This angers me, and I either am angered, or become desperate; however, I do not move an inch. Finally, seeing that my efforts do not lead to anything, I calm myself and refuse to continue this experiment.

My "countrymen" surely would have laughed about my position and would torment me for an hour or so, hiding and leaving me to my fate; but this time I was surrounded by creatures of another sort; they rescued me immediately from trouble, offering another experiment.

— Throw us, — they said, — anything, even the stick that you have in your hands.

[FOOTNOTE CONT'D FROM PRECEDING PAGE].

great number of small parts with intervals and, therefore, appearing semitransparent, as liquid or as spokes of a fast turning wheel? Diameter of this ring emerges 7 times greater than the diameter of the planet; such dimensions are not close to comparative dimensions of rings described by our miracle worker. And the actual asteroids, are they not disks inhabited by creatures and formed artificially by our narrator? After all, density and mass of planetoids are unknown to astronomers!.

I immediately throw the stick and see after that that my center position is disturbed, the chamber approaches closer to one wall; my movements are contrary to the movement of the stick and terminate in a few minutes by a gentle tap on the wall.

Another time, with the same conditions, I was proposed to be placed upside down, i.e., stand on my head; in a medium without gravity, naturally, there is neither up nor down,and any direction in a physiological sense is completely irrevelant; I speak thusly to be brief and clear.

No matter how I tried another direction, I did not succeed, and when I calmed down and adopted the previous more comfortable pose, my face was directed there too. No amount of effort lead anywhere; nevertheless, I could move freely all members, not any less than on Earth: I curled up like a roll, sat Turkish style (of course, not on a seat), folded my arms on my chest, threw them backwards, turned my head sideways, upwards, downwards, — in short: my body and limbs assumed all possible poses; but as soon as I took the ordinary position, it appeared that I did not move at all and did not turn at all.

The matter was simple.

— If you want to turn, take from yourself any object well, even a cap, and rotate it around its imaginary axis, parallel to which you also want to turn; watch the cap and do not let it flee; should anything happen — grab it, settle it nearly and again force it to rotate. Thus, when the cap starts to rotate, immediately you will note that you also rotate to the opposite side. You rotate as far as necessary — grab the cap: halt! Immediately you too will stop and will look already without any effort in a completely different direction.*

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*hold a cat by the back and hold it horizontally with paws upwards. Permitting it to calm down, take off your hands rapidly, so that it could fall, expecting nothing. You will see that the animal, doing a fast half-turn in air, will stand directly on its legs. How did this happen that the cat turned without support. Well, the fact is that there is support but it is not conspicuous, since it is inside the animal: they are his abdominal organs with their contents; they are capable of twisting with force upon the desire of the animal, by means of internal muscles, in either direction.

Thus, it is possible to rotate also around line of body, and around line of transverse (perpendicular to length of body), i.e., you can rotate also as a child's top, and as an acrobat on a trapeze, and sideways as a beetle on the pin of an entomologist.

The greater the mass of body the looser it is, the bulkier the more difficult to rotate it, — by the same token you will rotate faster, and it slower (ratio of angular velocities is equal to ratio of moments of inertia of bodies).

With repulsion the speed of the repulsed body is even greater the less its mass, and conversely. With equal masses you and the body rejected by you, fly in opposite directions with identical speed... Here there are many different laws; they are all known in detail to your terrestrial mechanics...

For the most part the movement of the body is complicated, i.e., the body rotates around the so-called free axis and at the same time moves forward, so that the axis has straight and uniform motion. The least effort is enough in order to obtain speed, if there is support, even as tiny and unstable as a drop of rain. But if it is lacking, then only external force is able to give you speed. Having speed, it is impossible to change it without support. Thus, I had occassion to fly at a distance of an arshin from the desired object and I could not obtain it because, not having support I could not turn to the side.

35. <u>How terrestrial weight was constructed on the ring for me; various experiments and observations</u>. Kindness, courtesy, and delicate solicitude regarding me by the natives made my stay with them positively a pleasant one. Once, on the ring, they offered me to use not only terrestrial furniture, which I also used earlier when I wanted, but also terrestrial gravity.

A huge empty metallic sphere, filled with air, light, and plants, renewing the atmosphere spoiled by my breathing and feeding me with very tasty and different kind of fruits (unknown to you - terrestrial inhabitants), served me always, when I wished to rest in ordinary, accustomed conditions. In this sphere there was not

gravity, for which I longed, there was not top or bottom; here you had no need of couches, mattresses, pillows, and beds; there was no need of hangers, or shelves. But in exchange for this there were light attachments for hanging things in their places. There were thin threads with hooks holding objects where they should be, hindering their raveling without any order; pots with plants were by the windows, and the light of the Sun nourished them, forcing them to bear fruits without rest, replacing with success the very nutrients of Earth.

Should there be gravity — all this will break off from their places, will gather in one outrageous pile. The comfortable furniture of space without gravity is not suitable for Earth, which has its own comfort...

Thus, this dwelling of sweet bliss was preliminarily converted: the bottom and top were determined below there was arranged a flat floor; on it there is furniture, a bed; on the wall hangs a clock with a pendulum; on tables there are carafes with water, oil, and various terrestrial devices and small objects. But how did your natives obtain gravity? — Readers will ask.

Oh, very simply and absolutely for free!

The sphere, adjusted to gravity, they connected by long and strong chains with comparatively significant mass, somewhat, however, exceeding the mass of the sphere itself, and this whole system was forced to revolve around the center of its gravity (so-called in mechanics "free center," its position coincides with the position of center of gravity). So that the system would not hinder the motion of rings, to its center was also transmitted motion of several meters, which was sufficient, so that it would be lifted above the ring and would float independently as a satellite of the planet.

With second speed of sphere of 50 meters and with chain 500 meters in length (nearly 1/2 a verst) in it was developed gravity from centrifugal force equal to terrestrial gravity.

Suddenly, I sensed myself in my native area, but I was not used to it and it stunned me, crumpled me, pressed me, put on chains, bound me, and in several minutes

I already beseeched my new friends to construct a lighter weight for me. But, before help came, I succeeded to recover, and get accustomed a bit. At first, I stretched on the bed and lifted my arm, then my leg, as if experiencing their weight and as though I did not believe its possibility; then I got up, sat a bit, arose, walked; wanted to jump but was not able, — apparently because lazy; somewhat later I jumped, but not high; walked up to the clock, swung the pendulum — it swayed, tick-tock, tick-tock... Poured water, drank it... Threw an eraser, it rotated, described an arc (parabola) and tumbled to the carpet; tilted the table — the pencils rolled... Experienced everything that I did not experience for a long time.

When, upon my request, my friends flying behind me (outside) decreased the speed of rotation of the system twice (25 meters), I felt only one and a half times heavier than on the Moon, because the gravity weakened 4 times.

Pendulum swayed twice as slow, water poured lazier; however, I sensed the force and jumped almost up to the ceiling.

I sat on an easy chair and looked around: in some windows one could see black sky with non-blinking stars, in another the bright dark-blue Sun shone. The whole celestial arch, with stars, Sun, and planet with its rings, it seemed to me, revolved around me as the center, making a full turn within 63 seconds. My room seemed absolutely motionless. My room became to me a planet; on the celestial arch I detected motionless points — poles around which it revolved very hastily. It is clear, the axis of the system can be arranged arbitrarily; thus, any star and even the Sun can be performed by polar points; in the latter case, the Sun seems motionless and gleams in the same windows giving the same shade.

With magnitude of chain 125 meters (but for obtaining of the same gravity) the speed will be only 12 1/2 meters per second. Full turn around the axis is accomplished in 32 seconds.

This weight, obtained by rotation, is eternal and does not require for its support the expenditure of forces.

I obtained the gravity which I asked for.

During acceleration of rotation the gravity increased and I experienced its paws more roughly; it reached to a point where there was not enough force to lift out of bed or to sit on it, and I tumbled on it with a bang. It came to the point where I could not lift a hand, and then I let it be known for experiments to cease.

In general, I was tired of this, and I again wished to feel myself in the delicate embraces of a space deprived of gravity.

While the rotation slowly stopped, I observed what an effect the gradual decrease of gravity has on certain phenomena.

Before me, on the table, there was a glass with water and immersed in it there was a glass tube; I saw how from the washstand water was trickling and drops of water trickled to the floor. The more the gravity weakened, the higher the water in the tube rose above its general level in the glass; also the water in it extended to the edges higher and higher, forming a deep depression; the drops dripping from the obstructed washstand became larger and larger: at first, like a pea, later as cherries, apples... but they neared the floor slowly and struck against it weakly.

Here the water already passed over the edges of the glass and began to pour out, tube filled to the top, and the last huge drop from the washstand almost stood in midair... Finally, all the water spilled over the edges of the vessels and disappeared, leaving the moisture... Pendulum hung powerlessly sideways; I with my easy chair was lifted into air, the bodies ceased to drop, everything stirred up, wandered... The illusion of gravity disappeared...

In space without gravity, gravitation between small bodies is easier to detect. Thus, inside the sphere whose mass by analytic conclusions cannot render any influence on bodies which are in it, all such have a tendency to join together, but speeds occurring from it are so insignificant that the bodies seem motionless, and a significant period is necessary in order to note their shift.

Two motionless subjects of average fullness, rendering at a distance of a sagene mutual attraction of 1/100 milligrams (weight of a sand grain), during the

first hour pass 18 millimeters, or nearly 1/3 vershok, during the next — nearly one vershok (54 millimeters), during the third — nearly 2 vershoks; all in 3 hours — less than 1/4 arshin; this means, each body passes less than 2 vershoks (80 millimeters).

Full approach of them in a standing position would demand more than 5 hours.

They could rotate one around the other (themselves, around the median point of their distance) and make a full turn for the duration of almost 2 days (44 hours) with the speed of 1 millimeter each 26 seconds.

It is understandable that one would not have enough patience to observe such a sluggish phenomenon, and it is difficult to establish bodies motionlessly: constantly you give them inconspicuous shocks and speeds which, however, is sufficient for the bodies to separate into equal angles and, comparatively, fast enough.

Lead spheres, each one weighing one kilogram, at a distance of 4 vershoks (2 decimeters) rotate somewhat faster, i.e., make a full turn in half a day.

If the solid lead spheres at the same distance* of centers (4 vershoks) were increased in such a manner that they would almost not touch, then their rotation will continue almost 2 hours (1.8 hours); and is unbearably slow.

35_1. Terrestrial view on the asteroid ring (continuation). The wisdom and power of my friends was amazing.

Once I said,

— ..., why don't I see our dear blue sky with gaily blinking stars, our mountains and seas? You know, here the sky seems black and the stars — death-like silver points...

And here they, because of one hint on my part, seeing my sadness, showed me the complete terrestrial view.

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*However, time of revolution of touching spheres does not depend upon their magnitude and distance of centers.

— In several minutes they already attracted me...

At first we flew, then gravity formed, and we were rolling along some long corridor... Finally, I closed my eyes and, when I opened them, I was sitting on the shore of a river under a willow shrub as if getting ready to bathe. With my whole soul I moved into the old world, and I had an uncontrollable desire to plunge into the cool waves.

Far off there appeared the hills covered by blue haze, nearer — the fields of grain swayed by the wind, several thickets and poor Russian villagers. The sky was blue and pure.

— Look, — they said, — how we will increase the waves of the river.

And they concerned themselves with the decrease of gravity. The more it weakened, the larger the waves became; the bigger they were the quieter they were. I myself felt the decrease of gravity, since the ground on which I sat became as if softer; and I saw the waves roll up to the mountains, ready to engulf me.

— On the oceans we would be able, — they noted, — to lift the waves several hundreds of sagenes in altitude and even higher, if only the water would suffice.

It was impossible to bathe, but they moderated the agitation, increasing the gravity to its magnitude it on the Moon (1/6 of the terrestrial). I began to bathe, and how easy it was for me to swim! It required very little effort to stay above water. But still, if one were to be at the mercy of fate, it wouldn't be hard to drown. When I dressed, got into the boat, and began to row, the more it emerged from water the stronger I rowed, and the more the gravity weakened. It reached a point where it hardly touched the water and moved rather rapidly. This was with decrease of gravity 30 times.

36. <u>Journey around the Sun; inhabitants without a planet</u>. All of us — inhabitants of the planet — travel around the Sun. As a safe carriage and untiring horses serve the actual planet; even you — inhabitants of Earth — do the same.

But how would you like to travel alone or in the company of your kind friends without a planet!

You saw that the inhabitants of the asteroids move freely above their planet and can even depart from it indefinitely far; you saw that the gun shell on the planet, half a thousand versts thick, passes from it forever, or having made a circle around the Sun, overtakes it from behind.

The matter here is the fact that the speed which you imparted to the shell, is taken away from it gradually by the gravitation of the planet; there remains the same speed for the shell, which it had earlier together with the planet, i.e., speed, sufficient in order not to fall on the Sun, but insufficient to depart from it forever. In one word, the path of the rejected body approximately coincides with the orbit of the planet itself.

But since it moves with almost the same speed as the latter or somewhat faster, they would not catch up to one another for hundreds and thousands of years.

On all asteroids the inhabitants have special mechanisms for convenient obtaining of speeds necessary for themselves and their belongings. You remember their multistory train for communication with the ring? Something similar to this also exists for them for full removal from the planet. However, on small asteroids, 5 versts in thickness and less, a good jump is enough <...>, in order to obtain the proper speed. Many inhabitants of such planets travel around the Sun, forming in space a number of villages, comprising a precious necklace — adornment of the skies. These are inhabitants without a planet.

On large asteroids the matter is more complicated.

The last train, or the highest platform of earlier described devices, loses gravity, but its speed is only sufficient for that and is not enough for a complete removal from the planet. If on this platform one were to put a new one moving in that same direction but only faster, then it will rise and will fly away or will burst into links and again will fly away, although it will not leave the planet forever.

What shall we do?

To the platform there are attached rails with free ends downwards, and on them already below, there roll wheels of the above-situated platform; so it is held by the underlying platform and could not be attracted by centrifugal force, if this underlying one could not fly away. Hence, it is clear that all platforms — to the last one of ground -- have to be linked with one another in this way.

Thus, these attachments aligned separately, are absolutely the same as the described ones; but inasmuch as the speeds of half of the highest platforms develop a force greater than gravity of the planet, and, therefore, the highest platforms could fly away or drag with themselves the lower platforms, they all are linked in such a manner so that they would never be separated.

A planet of density of Earth (as we ordinarily consider) and 56 kilometers in diameter should give the highest platform 50 meters of speed per second. A planet of 560 kilometers — speed of 500 meters.

During transition from the lowest trains to the center ones, the gravity gradually is decreasing, in the latter is completely destroyed; during further lifting the relative gravity again appears, but does not change the direction to the reverse and while increasing, in the highest train it is compared with the gravity of the planet.

In the upper trains a man stands, in relation to the planet, legs upwards From the last train should you only, so to say, fall, and you will fly away from the planet and become a satellite of the Sun.

Imagine that the gravity on Earth changed direction, and the Earth instead of attracting, repulses you into the sky (there — into the blue abyss), so that you can hardly hold on, sitting on trees upside down and clutching anything you could get ahold of!

The very same you experience on the highest train [asteroid]: from centrifugal force you adhered to the ceiling of its railroad car, and you only have to emerge from the small window, in order to fall into the sky.

falling about the train, this will be an actual fall (at least in the first minutes) you will fall, like a stone, with an increasing speed.

Here only one thing is good, i.e., the gravity which presses you to the ceiling is very weak and even on an asteroid 560 kilometers in thickness is 22 1/2 times less than on Earth, so that you can easily stop from falling, to the projection of the roof by holding on with the left hand. This effort corresponds to 7 terrestrial pounds, assuming your weight is 4 terrestrial poods.

From the center train one flies wherever one wants to and becomes a satellite of the planet or part of its ring; from the lower one — one falls downwards onto the planet; from the upper train — one travels higher the closer this train is to the last upper one from which we fly away into space, becoming an independent asteroid or part of the solar "necklace."

Annular multistory trains of the planet, moving along the meridian and revolving at the same time extraordinarily slowly together with it, obtain the possibility of rejecting bodies in all directions and with desirable speed upto known limit.

37. How does one manage in a medium without gravity? I already gave an idea about the laws of motion in a medium without gravity or in a medium of its apparent absence. We will describe the simplest devices for the practical needs of natives.

Here is the instrument for warning (to a certain degree) of vibrations or rotations of dwellings and such; it is comparatively stable, and not fidgety, in spite of forces which turn it.

This is a kind of room with two extraordinarily fast turning wheels on two of its adjacent walls; the massive wheels do not press on the bearings and, therefore, turn freely, without friction; but when one tries to turn this instrument — direct it in another direction, encountering more or less a strong resistance, depending upon the speed of disks, there is pressure of their axes on the bearings and friction which is overcome by weak solar motors. In such a room I could move, turn around and accomplish all usual motions — and it did not rotate noticeably, like an ordinary room without revolving disks.

Each of the latter ones became paired, i.e., they are from two parallel wheels rotatable by motors in opposite directions; their pairing is so that it would be possible to stop them or to accelerate rotation (for sheer stability), while not disturbing the immobility of the chamber.

To this there is added still another apparatus, permitting to establish a room absolutely arbitrarily before attaching stability to it. It also consists of a pair of jointly perpendicular, motionless wheels, simple, not double. When they are revolved, the chamber also revolves; when they stop, it too stops. At first, one revolves arbitrarily weakly one axis with wheel as long as the other does not take the desired direction. Then the first wheel is stopped and rotation is directed to other, so that the axis of the first also would obtain the desired direction. In such a way the chamber is established, as it is necessary, with the axes toward those or other stars, after which it is stabilized. Axes of wheels ordinarily coincide with imaginary "free" axes of the chamber. It remains to say how forward motion is transmitted to it.

For that the chamber has something like a long gun which fires bullets. In order to give to the chamber a known forward movement, it is established in such a manner that the gun would head sidewards, opposite to its desired path. Then one shoots (or moves the bullet by solar motors), and the chamber flies where ever necessary with the speed of several tens of meters per second, depending upon mass of the passing bullet and its speed. Firing another bullet in that same direction, we will obtain still the same (approximately) speed and fly with doubled speed. Thus there is attained the desired speed. To stop or to delay motion can be accomplished by firing the bullets in opposite directions. Firing the bullets in different directions, we can make angles and move on broken lines; throwing off a continuous stream of liquid or small bodies, we will obtain a curved motion, of the desired form. So that bullets, while flying, would not be damaged during encounters with other bodies, they are soft and friable, although massive.

During insignificant movements one uses a long chain with a mass on the end; the mass is launched not very strongly; the chain is twisted off from the shaft and departs together with the mass as far as permissable. At the same time in the opposite direction the chamber also departs. With great repulsed mass and long chain the movement can be quite significant. For instance, when the removed mass is equal to mass of the chamber with its contents and with a chain of 2 versts, the projectile departs from its place in any direction by a verst. The chain may be also still much longer because it does not break away from gravity, where there isn't any of it, is not bent, is not strained; the impact of the bullet is arbitarily weaker; the longer the chain the less damanging it is.

The natives rarely travel or live alone: and usually one, because of necessity of motion, uses as support the mass of the one who does not need it. Pushing away consecutively from very many, he does not change their motion noticeably, he himself obtains the desirable speed and heads where it is necessary.

Interesting joint evolutions of inhabitants [of the asteroid]. For instance, several of them in agreement will form various motionless figures: circles, triangles, etc., whereupon the position of the center of gravity of their general mass remains constant. Sometimes they are arranged in two round concentric chains. One chain, pushing away from the other, impart to it and itself reverse motions, forming two rings, eternally moving one near the other. It looks something like strolling. Now if the members of one of the rings is pulled into a closer ring, then their velocity — angular and absolute — increases, until finally, they have no more strength from the developed centrifugal force to pull together. During reduction, for instance, of the diameter of the ring ten times, the angular velocity will be increased 100 times, the absolute — 10 times, and centrifugal force will increase 1,000 times. Such a centrifugal force scatters their unliked members, against their will, in the direction of radii.

Sometimes two creatures agree, by means of a special missle, to be repulsed from each other the strongest way. The result of this is the fact that one of them

obtains high speed and instead of a circle, describes an ellipse around the Sun, while departing from the heavenly body; the other loses part of its inherent speed and, describing an ellipse, nears the Sun. If the repulsed were not one, but a pair, one of the pairs, for instance, that one which approaches the Sun, can split, and one from this pair will approach the Sun still more, and the other will depart. These evolutions are infinitely varied.

The inhabitants of very small asteroids (for instance, 1,000 meters in thickness and less) transformed their planet into a guided missile, imparted to it the rotation which they wanted, and thus made their day, according to desire, long or short; they gave to their planet greater or lesser forward velocity, and it would either depart from the Sun spirally, or near it. They controlled their planet, like we control our horses. When they neared the Sun, their year decreased, when they departed, — it was increased; the Sun then heated weaker and summer turned into winter. By approximation to the Sun — conversely — cold was replaced by heat. They changed the axis of rotation of their planet, each time forming a new polaris and equatorial constellations; thus they controlled the seasons.

They changed the position of the axis on the actual planet, while not changing its position relative to the stars. They changed the surface of their trajectory around the Sun and the actual trajectory, moving where it was necessary. They could have departed from the Sun forever and could throw themselves into its fiery mouth, serving as a drop for augmentation of the source of solar irradiation...

It is understandable that with all similar changes in motion and position the planet inevitably loses part of its mass, and the greater the more it accomplishes such changes; regarding, however, the work necessary for them, the Sun gives it to the planet.

The small asteroid was decomposed by its inhabitants into a ring so that there remained nothing of the planet and its weak gravity decreased still 100 times more. Direct interest of inhabitants was to turn their planet into a disk which would

K. E. Tsiolkovsky at work (1932).

FIRST LINE

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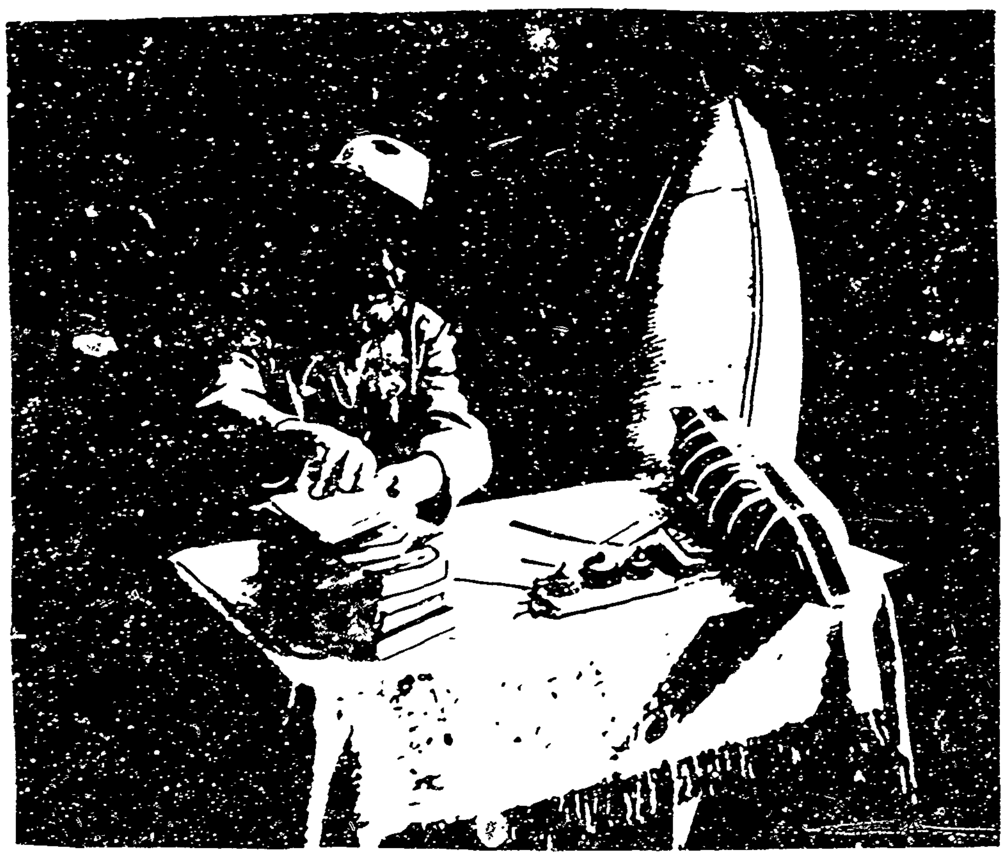

K. E. Tsiolkovsky at work on his project regarding the all-metal dirigible (1933).

seize a comparatively huge quantity of solar beams, giving the inhabitants life and force.

This ring, or disk, being dispersed in space, turned into a "necklace," i.e., into a chain of villages without soil, rotating around the Sun, as the rim of a wheel around its hub.

Even a huge number of big asteroids was turned into such hoops or "necklaces." In the solar system, as thin threads they stretch around the heavenly bodies. People do not see them because, although they may be a verst in width, even then with a length of several million or billion versts, they will appear in the best telescopes much thinner than a cobweb, hardly noticeable to the eyes. These threads partly govern their own motion, separating and changing their speed when there is a possibility to fall or to hold on to an unbearable planet which is flying excessively close by.

Nearby large, true planets there are no "necklaces." [Large] planets are fatal for them.

38. <u>From asteroid to asteroid and from "necklace" to "necklace."</u> We will explain how natives travel from one asteroid to another.

Here is a number of imaginary asteroids, well, let's say, each 6 versts in thickness.*

Let us assume that they accomplish around the Sun strictly circular motions on one plane and, although approximately, at double the distance of the Earth from Sun.

Calculations show that at the nearest distance from each other at 6 thousand versts, (even less, 3,000 versts is enough if there are not many asteroids), asteroids do not have a great influence on each other and in no case can collide, especially even if the planes of their orbits do not coincide.

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*Hence, the size of Agatha.

Every planet has a speed of 23 centimeters more (not more than 6 vershoks) than the one following it 6 thousand versts at the nearest distance. Hence, it is clear that the forward velocities of asteroids are almost equal and if they do not merge into one [planet], that is only owing to their weak attraction (1/2250 of Earth's), extremely decreased by their still comparatively huge distance; moving to one side, in a huge interval they travel together, one in view of the other.

It appears that one planet will overtake the other by a whole circle, i.e., will meet again only in 31,000 years. In one century the planet overtakes only by 1° (or by 1/360 of the circumference).

It is understandable that after that, flight from one asteroid another does not present the least difficulty and danger: imparting the proper speed to itself correctly, on the corresponding annular train, for instance 10 meters per second (32 verst per hour), we will arrive on the other nearest planet in 10 days. The difference in speeds is small, and a shock, during simple precautions, is insignificant. In case of error it is easy to change it in direction, having in reserve the attachment for motion described by us (sketch 37).

We know of nearly 350 asteroids between Mars and Jupiter, extending 46,000 terrestrial radii; on each asteroid the average distance is 131 terrestrial radius; however, even asteroids on the average have a mass and, consequently, mutual attraction is incomparably larger than our imaginary 6-verst planets. Their average difference of speeds will constitute nearly 60 meters per second.

This speed is not so great as to hinder reciprocal communication for their inhabitants. Again speaking in averages — one asteroid overtakes the other by a full circle and meets it again in 200 years. However, in actuality asteroids are very eccentric, they revolve by far not in one plane and have very different masses.

But do we know all of them, when in a year almost 10 of them have been discovered?*

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*All known asteroids are now close to 350. From them 220 are 50 versts less in diameter, 100 planetoids are from 50 to 90 versts, 30 — from 90 to 180 versts and, finally, Vesta, Cerera, and Pallada are insignificantly larger; the biggest — Vesta — in diameter attains 406 versts.

Inhabitants of "necklaces" are happy, free creatures: gravity does not enslave them; let it be everywhere; the transition from "necklace" to "necklace" several tens of thousands of versts is not at all difficult. Such journeys are accomplished quite often: some depart further from the Sun, others near it. In general, the motion of "necklaces," in spite of the constant role of support, almost does not change. Between Mars and Jupiter such a transition is especially easy since the asteroids hinder it little, especially, if one were to make a flight between parts of "necklaces" remote from the asteroid. All the more so because these parts only in several tens or hundreds of years will catch up to the asteroid. This means there is very little time for transition.

Also, the motions in other intervals are free, between neighboring orbits of other large planets.

Only transition from one interorbital space of two adjacent large planets to the other is somewhat more difficult.

We will take as an example the flight from the belt of asteroids to the belt between the orbits of Mars and Earth. At a distance of 200 radii to Earth from Mars — further or nearer to the Sun, i.e., at distances of 1 1/4 million versts, bodies traveling past Mars as planets — on circular orbits, are not subjected to any danger of being attracted to them.

Thus, between two "necklaces" insured from gravitation of planet there remains an interval of 2 1/2 million versts. While Mars is on the opposite side of the inhabitants of "necklaces," they can flash through this interval in one year moving with speed (cumulative speed in the direction to Sun, but not absolute) only 75 meters per second, or around 270 kilometers per hour; this speed will appear to us as insignificant for celestial spaces, if we will remember that even the multistory train of asteroids easily had a speed 5 - 6 times greater (500 meters per second); on "necklaces" where there is no gravity such speeds are obtained much easier.

Let us note, that the time for safe flight of the orbit of the great planet is

incomparably more than a year, since, for instance, Mars catches up to the external "necklace" on the semicircumference only in 60 years.

All this time, and even more, transition through the orbit of the planet is free.

Transition of orbit of Earth, having mass 10 times greater than Mars, is somewhat more difficult, but also, as calculations show is absolutely possible and requires speed for flight during half a year less than 500 meters. Other orbits of planets, the nearest to the Sun, are traveled even easier, by their smaller mass... <...>

38_1. Across the planet in 40 minutes. I happened to be on a spherical non-rotating planet with a continuous well, diameterically piercing the whole planet. For small planets, not exceeding 400 versts in thickness, such wells are quite possible, — in general, there are possible any kind of evasions from the spherical form.

If one were to throw oneself into this well, then in some 40 minutes you would reach the opposite outlet, where you can stop somewhat and where you can grab its edges and emerge to your antipodes. If, however, you do not wish this, you will eternally [rock] to and fro, as a pendulum. In all this time you do not experience gravity with respect to objects with you; but do not grab the walls of the well, otherwise the friction will quickly stop you. With little gravity in such a way it is easy to stop at any distance from the center of the planet; then we would see that in the middle of the well there is no gravity, but it increases proportionately to distance from it — to the very outlet.

It is remarkable, that no matter from what point of the well you start your fall, return to the former place is accomplished in the same interval of time (for a planet of Earth's density — 1 hour, 20 minutes), so that even small spaces, at least of several lines and larger — several hundreds of versts — arrive at one time. This is like a pendulum: whether you deviate it strongly or not — for its swinging requires approximately one time (isochronism of oscillations).

It is also remarkable, that also in other much larger and much smaller planets we, approximately in that same interval of time, accomplished this diameteric journey.

Theory indicates that should all the planets be of one form and density, the route from one of their edges to the other would always require the same time. If even through the Earth there was a continuous well, we would emerge to the antipodes through it upon the expiration of 40 minutes. But through the Sun, owing to its density which is 4 times smaller, this route would be accomplished in 1 hour 20 minutes, and through the Moon — in 53 minutes.

It appears that also the huge diameter of the Sun (more than 1 million versts) and the tiny clay ball are pierced by gravity force at the same time.

38_2. On three primitive asteroids. I had occassion to be on a primitive planet, untouched by inhabitants of the asteroid belt in memory of the past, as we save sites which are remarkable in geological respect. Good Lord! What an irregular mass! And from afar, and nearby it reminds one of some fragment, but certainly not our comparatively polished Earth. It's weight, because of its smallness is very small, infinitely varied in direction and pressure.

Once I was on a primitive revolving planet of almost spherical form. Due to rotation, the relative gravity on the surface of the planet was also strongly changed: at the poles of rotation it had the greatest magnitude and normal direction — to the center, but the further from them the weaker and the more its direction deviated to the equator, so that a man proceeding from the poles as if descended from a mountain which was more and more steep, although the pressure of gravity weakened and, therefore, it was simple to be retained on the increasing steepness; at a certain distance between the pole and the equator the direction of gravity coincided with the horizon, i.e., was parallel to the surface of the planet, and it seemed to you that you descend from a vertical wall. Further, the ground already appeared as a slanted ceiling, which on the equator turned into an ordinary horizontal terrestrial ceiling, and you had to grab on to something so as not to fall off

the planet. Here one had to stand with legs upwards like boys and acrobats do, with, however, the difference that blood does not go to the head, the face does not redden and you are not squeezed to the ground by huge terrestrial gravity, but on the contrary, the gravity strives to slightly detach you from those ledges to which you are holding on to. There are no stones here — all of them flew away from the planet under the influence of the centrifugal force and, travel around the planet approaching it only seldom.

Once the ledge to which I was grasping, was pulled off by me, and here I was smoothly separated from the planet together with the ledge; then with all my force I pulled away from the fragment captured by me, which began rapidly to depart from me and the planet; I, however, began to approach it; but since in this time I landed on a smooth part of the planet and there was absolutely nothing to grab on to, I had to depart from the planet again. At first, I moved normally on its surface and with increasing speed, I then noticed that I ceased to depart from it and even started to approach it. But I did not strike against it, but only slightly touched it, although quite at a different place, and again proceeded to depart normally. The impression was as if the sky repelled me with invisible hands and again set me on the planet, but the planet did not take me either, but also repelled me — without a blow and mysteriously. Thus, eternal lifting and lowering, and all on various places of the planet. This is a rare occurrence, i.e., that you would descend to a former place.

The faster the planet rotates, the further depart the objects torn off from the equator of the body. But even for complete removal from the planet the speed of rotation for small asteroids that is required is very small. With such a speed, objects are rejected from them by centrifugal force forever, and they become satellites of the Sun...

There was still another almost spherical and revolving planet, but with a comparatively huge mountain on the equator. Everywhere on the planet the preponderance was on the side of gravity except on this mountain, whose upper part, due,

to faster motion, developed centrifugal force exceeding the gravity of the planet. Rising from the foot of the mountain, we notice weakening of gravity up to a point where it disappears completely. Higher than this critical point it appeared again, but in the opposite direction, striving to throw everything away from the ground, and man had to walk on his head — more correctly — on his hands, grasping at anything so as not to break away.

On another similar planet stood an extremely tall tower, above and below it was thin like a spindle and quite without support, i.e., not touching the planet. We went under this castle in the air and were surprised why it wouldn't fall on our heads. The fact is that its upper part tends to fly away because of centrifugal force, and the lower pulls in the opposite direction. It's form and position are such that equilibrium is constantly observed.

38_3. Asteroid with a Moon. Between orbits of Mars and Jupiter there was still another planet, 56 versts in thickness, whose short history I will relate to you. It had a satellite in diameter of 6 versts. The satellite traveled around it at a distance of 60 radii of the planet (1,680 versts) with a speed of 4 1/2 meters per second (14 versts per hour), making a full turn in 28 days like our Moon.

From the planet, of course, it was not difficult at all for the natives to cross to the satellite (description 38), for which one day would be enough. They were tired of this satellite long ago, since with the force of its gravitation it produced disturbance and disorder in their rings which were revolving around the planet.

Therefore, they resolved to destroy it as a satellite and to convert to the very center, — at first, into a thin disk, and then subsequently — into a planetary ring.

A similar ring, due to its symmetric location and constant action, no longer disturbed the rings of the planet itself and did not prevent them to extend to the very satellite, altered into a ring.

Thus, the planet together with the satellites formed a system similar to Saturn with its rings.

The transformation of the satellite into a ring was accomplished by energy of solar motors within 10 years. Complete decomposition of the planet into a disk then took place within a thousand years. After that the disk easily turns into a solar necklace (description 37).

39. Temperature at different distances from the Sun. Force of solar beams increases with the decrease of their distance from the Sun, absolutely the same as force of its attraction. Hence, it appears that the temperature of solar system in space is infinitely varied. Partially that's how it is, but artificially this temperature can vary in the same place and, conversely, at various distances from the Sun it can be identical. The natives by very simple means obtain arbitrary cold where under ordinary conditions they would be decomposed from the heat.

The black surface, even at distance of Earth and in its atmosphere, under known circumstances, is heated up to 100°. What is there in a void with continuous action of beams and at a distance, for instance, 10 times closer, at which the Sun seems 10 times thicker, 100 times more extensive, lighter, and warmer?!

Imagine that the inhabitant [of the asteroid] in such a hot borough is screened by a brilliant metallic sheet, not losing from the increase of temperature his own reflectance. The screen reflects from itself a great part of solar beams, although it will glow at 300 - 400°.

This heat it disperses in space in all directions, and the native, at a certain distance from it in the shade, obtains already a comparatively insignificant quantity of heat.

Using another screen, standing behind the first screen in the shade and being heated only by it, we will obtain behind it at least a tolerable temperature for living creatures.

With the help of several screens located one after the another it is possible to lower the temperature, so to say, on the actual nose of the Sun, upto freezing

of water and alcohol.

Now you will believe that my mighty acquaintances did not fear to approach the Sun, although their constant residence was not close to it.

Conversely, those who departed from the Sun, increased the temperature artificially; we have many methods for this here. Imagine for instance a reflector or a concave mirror, and a living creature in the cone of beams reflected by it. It is understandable that nearing the summit of the cone it increases its temperature as much as necessary.

Such mirrors can have huge dimensions, be arbitrarily thin and weak; regarding their wholeness, in view of absence of gravity, there is nothing to fear; no need to fear the constancy of their brightness in view of absence of atmosphere.

The color of the native's clothes also has a great influence on the quantity of heat assimilated by him. The object whose black half is turned to the Sun, but the white side, brilliant, in the shade, is found in better conditions regarding the degree of its heating by the Sun. By this simple method, even in the belt of asteroids, natives obtain the temperature of human body. If you are hot in such a position, turn a little and the temperature will drop.

By its constancy, this temperature, obtained in celestial space, is extraordinarily healthy: neither day, night, winds, humidity, nor rains — nothing disturbs its regularity and complete dependence upon the intelligent creature.

Constantly and arbitrarily...

... Don't you think that this is splendid!?

Simple screens first lower it, then increase it depending on whether they protect the object from loss of its own radiation or from the radiation of the Sun. Protecting the body from its own loss of heat, the screen, reflecting at the same time solar beams on the object itself more than ever promotes increase of its temperature.

Lateral screens also have influence; solar rays only slide along them; they delay the radiation of the body. Thin conductors of heat also render influence,

i.e., clothes.

FIRST LINE OF T

With the help of various means the natives have so neared the Sun that glass melted and flowed because of its beams like water; chemically complicated substances were decomposed exceptionally fast into compound elements.

They departed also so much that in the shade, under the protection of a series of screens, they obtained temperature, and from the small temperature of which the gases turned into liquids and, freezing, became hard as steel. Hydrogen kept well in brilliant metallic form (like blue steel).

It's a great convenience to obtain great contrasts of temperatures at any place, almost next to you. These contrasts were applied by natives for the simplest and the most profitable transformation of energy of beams into mechanical work of the heavenly bodies. But one of the forms of solar motors we already described.

40. From star to star, or from Sun to Sun. Once I asked my friend:

— Here you live under the care of the Sun, having no need of food, except for light... What will occur when there won't be any of this light?.. After all, the Sun will not shine eternally! And our terrestrial mathematicians found that it will burn some tens of millions of years, but then will be covered by a dark crust or thick clouds and will be like Jupiter from which we are neither hot nor cold... Could it be true that you are doomed to perish?

— First of all; even your mathematicians know that universal gravitation is an inexhaustible source of energy; their assumption of the ceasing of solar radiance is based on the fact that the Sun cannot be solidified more intensively than the Earth, or something like this... Such a concept is incorrect... Secondly, even if the solar radiance should cease for a time, that of course, we will recognize thousands of years earlier, then nothing hinders us from flying to another sun and living there until its extinction... There are stars which are 10 times* larger

*Diameter of Sirius is 14 times greater than the solar diameter.

than it, and by your theory such stars should shine at least 1,000 times longer than the Sun...

We should wander from star to star because of their extinction, until the same stars would reignite with new light, more abundant and more beautiful...*

— But how could this be, — I objected, — interstellar distances are so terrible... When will you reach another hearth, another source of life, if light travels months and years for that?

— Light takes years to travel, and we are not in a state to move with such speed, — they answered. — On our "necklaces" we obtain speeds similar to planets, i.e., upto 100 kilometers per second and more. Thus, if light travels years, we "crawl" the same distance within thousands of years; if it travels months, then we would take hundreds of years.

— How do you live for these thousands of years? Could it be by weak stellar light which accompanies you during your gloomy journey?

— No, we live by reserves of solar energy, as you live by it constantly.

— This means, you are then transformed and fed in our manner?

— Not at all. We only convert reserve energy into light which support our life like the Sun. This is similar to the way you transform solar energy, concealed in carbon, into mechanical work, and this latter one into electrical light.

— How much energy is necessary, how much reserve for a thousands years and for a million beings?

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*According to hypothesis of Boskovich, accepted with insignificant corrections by the great Faraday, matter consists of centers of forces from mathematical points connected between each other by attraction or repulsion, whose law for molecular distances is unknown. And if this is so, nothing hinders matter infinitely to be solidified. This solidification can serve as an inexhaustable source of energy given off by Suns in the form of heat and light. For instance, for a long time water was considered incompressible, and what happened? According to Cailletet, water is compressed proportionately to pressure, as gas only 20 - 30 times weaker than air compressed upto density of water. Experiments were produced upto 705 atmospheres. There is no basis to accept limited compression of bodies. In the same way are compressed also solid bodies (Buchanan). Thus, the pressure in the center of the Sun should solidify steel 600 times.

These reserves are carried without any effort, in large quantities and limitless time, the known principle of inertia. And for each of you the reserve of a thousand years of food is small, and for us even smaller. A cubic kilometer of grain contains a thousand year feeding for 3 million people; a ten-verst cube has a reserve for 3 billion people. Such a reserve on our rings and "necklaces" is prepared by the Sun in several seconds. Finally, we can exist in a state of blissful lethargy, and thousand years in this half sleep pass for us as minutes, like your deep pleasant sleep.

Such a state requires only definite temperature and comparatively little light...

41. Return to Earth. How many years passed, I do not know. The time has come to leave my kind geniuses.

With my human and sinful heart I become so attached to them, to their life, to their situation and to their generosity with which they constantly surrounded me...

I found them beautiful, as old precious vases, I bowed before them as before the highest products of the human mind and heart... <...>.

Yes, my friends, I told you many wonderful things, but I did not relate even a millionth fraction of what was in actuality...

What I saw and where I was! — In one solar system. And how many such systems? — In one Milky Way there are a billion of them. And how many Milky Ways? Who will answer this?.. The world is infinite...

VIII

Energy of the Solar Rays

42. Its complete energy. We said (descriptions 3 and 4) that if one were to imagine the Earth as a pea, the Sun would be a healthy watermelon, situated at distance of 180 steps from the pea-Earth. From this it is seen how comparatively insignificant is the quantity of solar energy allocated to the Earth.

Energy of all the beams, however, emitted by the Sun, is so great that if we convert it in full into mechanical work, then it, overcoming the strong attraction of parts of the planet, would decompose them mechanically into a mist within a very short interval of time. All the more easier it would change their form, giving them the form of a cube, pancake, ring, etc.

We will note here two things: first, no physical energy passes in full and without remainder into mechanical energy, but one can design motors which in a void transform (approximately) 1/5 of solar energy into mechanical work; secondly, I do not concern myself here with methods of dividing parts of the planet or change of its form, I only assume that these are the methods which are perfected to such an extent that with this process the work of beams is utilized completely.

All the following presentations will be considered as similar, practically impossible conditions.

Our greatest planet, Jupiter, decomposes mechanically into infinitley rarefied mist* in 115 years; full solar energy decomposes the Earth in four days; the Moon in 3 minutes; a planet or satellite, twice smaller in diameter, decomposes faster than in one second.

This energy is in a state to heat up to the center a cold (by assumption) globe to 3,000° C in twenty-four hours. It can heat a mass of ice water, equal in volume to Earth, to 100° C and then to convert it into steam in the course of 4 hours.

Its three day energy corresponds to energy of carbon, equal by volume to the Earth (density of carbon will be considered equal to one), during its combustion in oxygen.

In one second it gives more strength than food gives, prepared for subsistence of two billion people (greater than the population of Earth) for 25 million years.

Here you will involuntarily exclaim: what wealth our Sun gives forth every second, but we do not know how to use it, and it goes past our hands!

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*Comparatively insignificant cohesive force of matter (adhesion, etc.) is not taken in account here.

A water globe decomposes chemically by solar energy into its compound elements (hydrogen and oxygen) almost in twenty-four hours.

The complete energy of the Sun, converted without remainder into mechanical work, can impart to the Earth in 11 hours its diurnal rotation around the axis; to an asteroid with a diameter 10 times smaller, the same diural motion (this means complete revolution in twenty-four hours) is imparted in half a second.

Forward motion of Earth around its axis is obtained in almost a month (0.1 year); however, the motion of the Moon around the Earth takes 3 seconds.

Particularly great is the energy in relation to formation of small planet-asteroids which it rubs, presses, gives them any form, decomposes into mist, decomposes chemically, gives forward motion, removes from the Sun, brings them to it, causes to fall on it, casts into limitless space <...> within a few seconds or fractions thereof. And our Earth itself in comparison to it is nothing: solidification of its atmosphere into liquid, decomposition of planets substances of all kinds — chemical, mechanical, and physical, — the formation of any form or motion, — this is all a matter of many days, months.

43. <u>Part of energy obtained by planets</u>. However, planets use only a small portion of solar energy; thus, the Earth obtains it from the Sun 2 1/2 billion times less than it is dissipated into space. And all the planets united obtain much less. Saturn, for instance, not considering its rings, obtains almost as much as the Earth; Jupiter — about 4 times more; Mars — about 8-9 times less; Venus — about 2 times more... so at least 100 million times more is lost than is utilized. Yes, and how it is utilized!?*

We will assume that the solar beam energy, falling on Earth, equally distributed on its surface, is completely converted into mechanical work; then for each square

*If one were assume that on the average each hectare (dessiatine) of Earth's surface in one year gives 2 tons (120 poods) of grain, sugar, and similar nutrient substances, it would appear that only 1/5000 of solar energy is utilized.

meter there will be 1/2 horse power, acting continuously, day and night; for each square of 5 sagenes in length, in other words, there is 75 horse power. With the work of these imaginary machines a layer of water 1 meter in thickness, equally covering the whole Earth, rises from it tirelessly with the speed of 5 centimeters per second; in 24 hours this mass of water raises upto heights of 4 versts (4.32 kilometers), and in 3 months sets outside of the atmosphere's limits (300 versts).

This work exceeds the work of all people at least 17 million times; if for each square meter of surface of the Earth one would place 5 healthy workers capable of working untiringly, their work would be comparable to the work of solar beams on Earth. In practice, mechanical work of beams is much less; it produces winds, movements of water... a large part of it converts directly into heat, which radiates into celestial space.*

If the gravity on all planets was identical, then mechanical effect of solar force everywhere would be the same, i.e., on each planet half a sagene of layer of water would rise continuously with speed of 5 centimeters per second; but on the Moon, for instance, the gravity is 6 times less and, therefore, this layer will pass almost 1 foot per second. Hence, it is clear that on small planets the relative action of beams of Sun is much more noticeable.

The whole Earth is mechanically decomposed by energy, alloted to it during 26 million years. Isn't it true, that I stunned you with the might of gravitation? Actually, in large planets it is very perceptible. But we will take small planets. For instance, the Moon is decomposed already only in the course of 170 thousand years: and that 6-verst asteroid,** which our eccentric concocted and described

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*With time all mechanical and chemical work of the Sun is converted into heat. Hardly anywhere are there accumulated peat bogs and their facsimile presenting potential solar energy. Earlier these reserves were accumulated more intensely, forming powerful layers of coal.

**Or planetoid Agata, assuming that it has spherical form and the average density of Earth (5 1/2).

(description 31), — energy of rays obtained by planet, — decomposes only in a week; the subsequent asteroid 56 kilometers in diameter, — in 20 years, another still large one (560 kilometers) — in 20,000 years.

But we saw that small asteroids, having the possiblility of forming a ring around themselves, can use also incomparably high energy of the Sun; if one were to allow an increase of surface, only by 100 times, illuminated by normal solar beams, then also the given times will be extraordinarily reduced. For instance, the decomposition of an asteroid 560 kilometers in thickness will only take 200 years.

The periods for alteration of planet into all possible forms would be less than shown. Time of alteration into a revolving thin disk, composed of rings (similar to rings of Saturn), rotating with different speed and overcoming by their motion the force of attraction of their parts is also less than the given numbers.

However, during conversion of the whole planet into a very thin and, consequently, weakly revolving disk, the work is only slightly less.

Although the existence or, more correctly, the formation of rings around a large planet, similar to those which Saturn has is inconceivable, due to extensive speeds which they must have so that they would not fall on the planet (or be destroyed by gravity), and also due to resistance of atmosphere of the planet (whence it will be necessary to start the process of motion) and, probably, due to a great number of other causes, — nevertheless, wishing to give a concise idea about the relation of solar energy, obtained by planets, to energy of gravitation, I relate here results of calculations of such kind.

A disk 1 centimeter thick made from material of density 3 (almost the density of aluminum), consisting of a whole series of rings revolving with various speeds, and having a diameter 10 times larger than terrestrial, is formed around our planet, by energy of beams obtained by it during three years (2.63 years).

If one were to take into account that with the increase of number of rings, or dimension of disk, there is increased also the force which forms it, then time of

its creation will be much less.

A similar disk on the Moon, with its diameter of 10 lunar laterals, would take a 40-day operation.

If one were to decompose (mechanically) planets to the very center, i.e., fully, and to use the continuously and rapidly increasing surface of the disk as a [capacitor] of solar work, then, it is understandable, this decomposition can be accomplished a time, by far not as terrible as given by us. The Earth would have been decomposed not in 26 million years and the Moon not in 170 thousand years. And these periods, theortically, could have been shortened a thousand times.

I repeat that all this is pratically impossible, and even if it were applicable, then only to small asteroids not surrounded by atmospheres and being some hundred versts <...> in diameter.

IX

Gravitation as a Cause of Speeds of Celestial Bodies and Their Radiation

44. Formation of Milky Ways and their rotation; formation of Suns with planets and their satellites; their rotation. The original nebula under the influence of thickening of matter by gravity force, was divided into an infinite number second order nebulae. These were divided into a great number of third order nebulae, etc., similar to how the external layer of Earth, compressed from that heat and loss of moisture, cracks into big and small parts or how a continuous mass of steam, condensing in the air, forms drops.

We cannot resolve the question, from what order of nebula was formed our disk-like Milky Way and group of stars which are similar to it, seen from Earth because of remoteness more or less as round specks of mist.

For simplicity, we will consider the nebula from which developed the Milky Way and a heap of stars similar to it, the first order nebula. Hence, the Milky Way

will be a second order nebula, and the nebula from which there formed the solar system and ones similar to it, — third order.

I ask: when the first nebula, not having, let us assume, general rotation, was divided into parts, could they, with this burst, have obtained a general, although extremely weak rotation?

If two men were attracted to one another through their hands, it is obvious that, besides forward motions, they would have immediately picked up the rotation and be destroyed by friction against the soil. Tilt with your hand and make the pendulum, which was hanging on a thin thread, swing in such a manner so that it does not rotate... It is impossible to throw or to move an object so precisely, that it would not obtain at least the slowest rotation.

Kick a stone on smooth and pure ice and you will also be convinced in the same thing. Theory of probability does not allow that during burst of nebula, its parts would not obtain reverse rotations.

The rotations of all parts in one direction (assuming that the first nebula did not rotate) is not permitted by the laws of nature, but reverse rotations are more or less permissible and are necessary.

Thus, nebulae of the second order, during burst of main nebulae, obtained rotations which no matter how small they were at first, by measure of their thicking increased more and more. Having several meters of speed in periphery (on edges), they increased this speed a thousand and hundreds of thousand times, when the diameter of the nebula, due to thicking, attained dimensions of the Milky Way or star clusters similar to it. This conclusion is strictly mathematical. The work of rotation is obtained during thickening of matter, the potential energy of gravitation, whose reserve according to theory, is infinite.

But in fact do the stellar nebulae and Milky Way have similar rotation?

Their disk-like form convinces us of this; solar motion to the constellation of Hercules, i.e., almost in the plane of the Milky Way, confirms the same.

Let us go further, and assume that the nebula of the second order, Milky Way, for instance, in turn condenses; there occurs its burst into billions of nebulas of the third order, each one of which serves as an ancestor of the planetary system with a central star — the star, or sun, at the head.

Here, of course, there should occur the same as during burst of the nebula of third order; for instance, that which served as the ancestor of our solar system, obtained more or less weak rotation, which is added to the general motion, although also rotary, but with such at comparatively huge radius of curvature that this initial motion can be considered almost rectilinear. Thus is explained not only the forward solar motion (around some center, somewhere far away, in the Milky Way), but also the rotation of Sun and all planets by known law (description 5).

Weak rotation of the third nebula is strengthened by measure of its thickening. But during this thickening there occurs its usual burst into parts or rings, which, bursting, in most cases form spherical masses or ancestors of planets with their rings and satellites.

With these, at first spherical, nebulous masses of fourth order there is repeated the history of bursting described by us and acceleration of rotation, where upon there are formed bodies of fifth order — ancestors of planet satellites or rings such as we see in Saturn.

This theory, proposed by Laplace, excellently explains the motion and rotation of the Sun, planets, and their satellites in one direction.

45. <u>The grandiose picture of the Universe created by the life of wonderful beings</u>. Not concerning ourselves for now with gravitation as causes of radiation of suns (from afar — stars) during millions and billions of years, we will pay attention to the grandiose picture presented to our mental glances.

Telescopes in one Milky Way count up billions of suns. But how many of similar Milky Ways, whose huge totality constitutes only a sand grain in the creation of the universe?!

An infinite number of stars, or suns, glittering (if one were to approach them) even brighter than our Sun, are surrounded by an even more infinite quantity of

planets — dark celestial bodies obtaining heat and light from their suns.

FIRST LINE OF TEXT

Our solar system counts them by the hundreds (350); one of them is called the Earth. And how many such lands are there in the world and with conditions almost identical to our Earth!?.

... Could it be probable, that Europe is populated, and the other parts of the world are not? Could there be one island — with inhabitants, and a great number of others — without them? Could it be probable, that one apple tree in the infinite garden of the universe is covered with apples, but all the infinite number of others only have green leaves!?. Spectral analysis indicates that the substance of the universe is the same, as the substance of Earth... Everywhere there is life in the universe. This life is infinitely varied. If life on Earth is varied at comparatively monotonous circumstances, then how infinitely varied should life be in the universe, where any conditions are possible!

All phases of development of living beings can be seen on various planets. What humanity was several thousand years ago and what it will be upon the expiration of several million years — all this, according to the theory of probability, can be found in the planet world.

All that is wonderful which we expect with trepidation already exists, but we cannot see it because of the length of distances and limited capacity of telescopes...

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ON VESTA

Let us turn to Vesta. This, although not freedom, is the anticipation of freedom. Vesta is the largest asteroid. It moves around the Sun almost in a circle. If it is spherical, the average diameter of the planet is no more than 400 kilometers. Although it has the same density, as Earth, its gravity is 30 times less. If there is liquid and gasses, then the liquids must not hardly evaporate, and gasses must have huge molecular weight (at least 5 times more than oxygen) in order not to be volatilized with such small weight. All this is possible. Even on Earth there is liquid which hardly evaporates. In such cases in these liquids can be engendered and produced life, as in our oceans or atmosphere. Only the role of oxygen will be played by any heavy gas or unevaporated liquid. Even one transparent liquid is sufficient. Then this liquid will replace atmosphere for creatures.

Creatures of a liquid medium on Vesta gambol and float as fish; they jump sometimes from their sea (as flying fish into air) into vacuum, emerge on elevations not flooded by liquid. But here they start to choke and return hastily to their own medium.

Some of these creatures are fed by plants and the weakest living creations; others live only on sunshine, as a plant. A third group connects the function of plants and animals, as our actinium and so forth, i.e., they contain chlorophyll.

Beams of Sun penetrate through the transparent cover of their body and produce there chemical phenomena, bearing life.

And these last creatures also emerge from seas onto the heights into the vacuum and are delighted by the primitive force of the solar beams. The process of life in them continues even in the emptiness, but the body loses part of the liquids, although only weakly evaporated. The creatures after several hours have to again depart into their sea. As our water creatures who emerge sometimes from water.

Some of them are covered by a shell permeable for beams, but hardly permeable for substance. Such can remain in a vacuum for an extraordinarily long time. Loss of substance from their body they renew very rarely: either from liquid or from the surrounding mineral mass. Having absorbed this mass, they tightly close their mouths.

At first the creatures conducted one part of life in the oceans and the other in the emptiness. Then the first period (in liquid) became shorter and shorter until at last it ceased. Birth and all life passed on land and in emptiness. This phenomenon is similar to the adjustment and palingenesis of the water animals of Earth to land.

The mind of these creatures is increased. They, by various artificial methods, more and more strengthen their life in the empty space and improve it.

In time their oceans were destroyed, dispersed, — their population perished; the creature on land remained and they rule.

But how could people live here? We will assume that these creatures are still more cultural and more reasonable than people. And this inevitably should happen. If we give them sufficient time for culture, then they will help us to settle on Vesta. They will construct spherical or cylindrical chambers consisting of strong grid-mounts with a great number of transparent plates-windows. In them

will be oxygen in 0.1 air density, a little carbon dioxide, and water vapors. In these chambers will be fruit plants with humid soil. They will bring fruits, necessary for our satisfaction. Plants give food and oxygen. Our secretion serves for their feeding. We breathe, are fed and secrete. Thus also do plant. The eternal monotonou exchange, eternal energy and life.

In cylinders we are disposed, as at home. But we can emerge from them into the vacuum, for which it is necessary to dress in a special manner. We dress in flexible and very thin clothes impenetrable for substances. Between this shell and the skin there is a continuous circulation of rarefied oxygen. Before the mouth, nose, and eyes there is more space, before the eyes there is transparent glass. We breathe this oxygen, give off carbondioxide and other gasses and vapor. Passing through special attachments of the clothes, they are absorbed there, and oxygen in the same way, is continuously given off from another attachment. A kilogram of oxygen suffices for the whole twenty-four hours of tense life. But since man in 5 - 6 hours tires and wants to eat, then a half pound of oxygen in a weak chemical compound and liquid form is sufficient.

Neither clothes or these insignificant attachments can constrain or burden man. The machine with pumps, shell, and substances which absorb human secretions and give oxygen, — all together will constitute a mass of no more than 3 kilogram, which on Vesta constitutes a weight of 100 gram.

On Vesta we are disposed as at home. We do in the vacuum all that we want. And when we tire, thirst, and hunger then we return to the transparent cylinders, remove our pressure suits, drink, eat, and rest, i.e., do all as on Earth.

We stroll in freedom on the surface of Vesta in our light shells, freely breathe, look around.

First of all, the temperature! The average distance of Vesta from the Sun is 2.36 times more than the distance of Earth from the Sun. The temperature of the dark surface of the planet, with which our bodies merge, by the table and

calculation, reaches 0° C. This is very low; the more so because this is maximum, but nothing hinders us from raising it by various methods.

In order not to chill, we will resort now simply to warm clothes. They are 30 times lighter than on Earth. Therefore, they will not constrain us, and will only warm us.

We look around. The diameter of the Sun is 2 - 3 times less, but it shines unbearably. Illumination, in intensity, is very similar to solar eclipse during a clear sky and small phase [1:6]. Also the soil of the planet shines brightly. Under the influence of this brightness the pupil narrows, and we see around only the biggest stars on a black sky.

But if one were to turn the back to the Sun and close off, by the palm, the light of the soil, then one will see, somewhat after the pupil is expanded, an infinite number of stars. It would be like looking through the summit of the blackened inside of a cone.

The sky has, as on Earth, the form of an arch, only not flattened from above, but absolutely spherical; it is black as soot, and is studded with the same constellations, without the least change, as on Earth. Only stars are much larger; they do not blink, and for people with good sight they seem points, without beams. At night it is the very same, only the stars seems larger.

Zero temperature on Vesta, or in general in a vacuum, is not at all as it is on Earth, especially during a strong wind. Loss in vacuum is accomplished only by radiation. Thus, it is difficult even to imagine how warm it is (with the lightest clothes) on Vesta at zero temperature and even lower. If one were to surround oneself from five sides with screen, well reflecting radiant energy, and leave the sixth side open to sun rays, then the temperature of the body can be lifted terribly. But now in this there is no need. On Vesta light black clothes and sun rays are enough. They could inflict a solar blow, since they are not weakened, not rendered harmless by atmosphere; but then clothes colored

properly and transparent plate before the eyes can protect us.

We will move, lift weight, work, talk, etc. Our words are not audible. But if between the pressure suits of two men a thread is stretched, then they can talk excellently even at a great distance.

On Earth I can freely carry one man of such a weight as I. This means, in essence, I lift two, myself and another. On Vesta with the same ease, I can carry 30 times more, i.e., 60 men, but subtracting myself - 59 men. Consequently, without strain — 4 ton. This will constitute 4 cubic meter of water or 8 barrels with water.

On Earth, dropping 50 centimeters and quickly straightening, I can still jump 50 centimeters. All I can rise is 1 meter. On Vesta the same effort gives a jump to an altitude 30 times higher, i.e., 30 meters. This is the height of a ten-story home, the biggest pine, or a respectable hill.

Second acceleration on Vesta constitutes nearly 30 centimeters. This means, a body there in the first second, dropping, is lowered 15 centimeters. Man, during a vertical jump, obtains in the first moment a speed near 4.5 meter. Consequently, during a jump man is lifted on Vesta for 27 seconds. He flies downward as long. This means, this flight will last 54 second, i.e., nearly a minute. What is it possible to perform during this flight...

The most profitable (distant) jump should be made at an angle of 45° to the horizon. Then the lifting vertical will be twice less, namely 15 meters, but the horizontal shift will constitute 60 meters. This means, there it is easy to cross over ditches and pits with the width of a respectable river. It is possible to jump over 15-meter trees and homes. And this without running*

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*This was written before 1919.

BEYOND THE EARTH

1. Castle in the Himalayas

Among the greatest spurs of Himalayas there stands a beautiful castle — a human habitation. A Frenchman, an Englishman, a German, an American, an Italian, and a Russian recently settled in it. Disillusionment with people and joys of life drove them into this seclusion. The only delight left for them was science. The highest, the most abstract strivings constituted their life and joined them into a brotherly hermit family. They were fabulously wealthy and freely satisfied all their scientific whims. Expensive experiments and facilities constantly emptied their pockets, but could not exhaust them. Communication with the world was limited by these facilities, for which, of course, there were required people and people, but as soon as everything was ready, they again became involved in their research and in their solitude: in the castle besides them there were only servants and workers whose excellent dwellings huddled around it.

2. Enthusiasm of Discovery

On the very top of the palace there was an extensive glass hall, where our anchorites particularly enjoyed meeting.

In the evening, after sunset, through the transparent dome of the hall there sparkled planets and countless stars. Then the thought involuntarily led to the sky, and conversation commenced about the Moon, the planets, the countless, but distant suns.

Desperate dreamers! How many times they created senselessly bold projects for journeys over celestial spaces: but their own very extensive knowledge unmercifully smashed these fantasies.

One fine summer night three of our friends were peacefully conversing on various gay topics, when suddenly, as if a storm, burst in the Russian and threw himself on their necks, — he squeezed them to a point until they groaned and squeaked pitifully.

Pray, do tell — exclaimed, finally, the Frenchman, Laplace, freeing himself from the strong embraces — what does this mean? And why did you vanish for so long in your office? We even thought that some misfortune befell you during your experiments, and wanted to intrude by force.

— Oh, this is terror, terror what I devised. No, this is not terror — this is joy, enthusiasm...

— What is then the matter? You are as though insane, — said the German, Helmholtz, who had suffered more than the rest.

The sweaty, red face of the Russian, with tousled hair, depicted some unnatural enthusiasm; his eye shone and expressed bliss and fatigue.

— In four days we will be on the Moon... in several minutes beyond the limits of atmosphere, in one hundred days — in interplanetary spaces! — the Russian, named Ivanov, blurted unexpectedly.

— You are raving, — said the Englishman, Newton, looking attentively at him.

— In any case, isn't it too soon? — doubted the Frenchman, Laplace.

— Gentlemen, I am swept away, this is truth, however, I beg you to listen to me and to send for the rest of our comrades.

When they arrived, all were settled at the round table and, looking into the sky waited impatiently for the report of the Russian.

3. Discussion of the Project

— Oh, friends, — began the Russian, — how incredible is the thing which I devised!

— Judging by your intentions, we had not considered this, — said the Italian, Galileo, to whom they had already managed to report briefly about the event.

— You are familiar with energy of combustion, — began the Russian. — I will recall the figures. A ton of oil, during combustion, yields a quantity of work which is in a state to lift the same mass to heights of several thousand of versts from the surface of the Earth. One and a half tons of oil is capable of imparting to one ton, a speed which is sufficient to depart from Earth forever...

— In other words, — interrupted the Italian, — a mass of combustible substance 1 1/2 times greater than mass of man, can impart to him a speed, sufficient for his departure from Earth and his journey around Sun...

— The Russian, probably, has devised a gigantic gun — interrupted in his turn the American, Franklin. — But, first, this is not quite, and secondly it is absolutely impossible...

— After all we had discussed this sufficiently and rejected it long ago, — added Newton...

— Let me talk.... You did not guess, — pronounced the Russian with annoyance. Everyone quieted down, and he continued.

— Truly, I did devise a cannon, but a flying cannon, with thin walls and firing gases instead of a shell... Have you heard about such a cannon?

— I don't understand a thing, — said the Frenchman.

— But the matter is simple, I am talking about something similar to a rocket.

— Is that all? — exclaimed the ardent Italian, with disillusionment. — Rocket — this is something insignificant; with this you will not surprise us...

You don't really want to depart for celestial space in great rocket?

FIRST LINE ...

The company smiled, but Newton pondered, and the Russian answered,

— Yes, in rocket constructed in a special manner. This is comical and, apparently, is impossible, but strict calculations say something else.

Newton listened attentively, the others stared at the stars...

When everyone again turned to Ivanov, he began:

— The most incontrovertible calculations show that explosives, flying out of the muzzle of a sufficiently long cannon, can attain a speed of up to 6 thousand meters per second. If one were to suppose that mass of gun is equal to mass of exhaust gases, then the muzzle will obtain reverse speed of 4000 meters. If the mass of the explosive substances is three times greater, the speed of the muzzle will be 8000 meters. Finally, with a mass seven times greater, the muzzle obtains a speed of 16,000 meters per second, which is more than is necessary for departure from the Earth and a journey around the Sun.

— For that second speed of 11,700 meters per second is necessary, noted Newton. — But, please, hurry and describe to us your rocket.

— Yes, yes! We are listening, — they all cried out; and the loudest of all was Galileo.

— Imagine all egg-shaped chamber with a pipe located inside of it and passing outside of it. In the chamber, place reserves of explosives which gradually are released through the pipe downwards during detonation. Continuous detonation of the substance and exhaust of combustion products with great will cause a reverse, continuous tendency of the chamber to move upwards with increasing speed. Here there can be three cases: when the pressure of exhaust gases does not overcome the weight of the missile when it is equal to weight of missile; and when it is greater than the weight. The first case is not interesting because then the missile does not move from its place and without support it falls. Its weight only decreases. ~~In the~~ second case — it loses all of its weight, i.e., does not fall without

support; in the third case, the most interesting, the missile rushes into the heights.

— It can be suspended with the use of detonating gas for 23 minutes 20 seconds, when the weight of explosives seven times exceeds the weight of missile with all contents, — noted Laplace.

— Absolutely true! But being stationary in air would be useless for us, and therefore we will not remain with this case; I will only note that then the apparent weight inside the missile does not change, i.e., all objects in it remain at the same weight.

— You, without doubt, assume, — interrupted Newton, — that the cannon is fixed vertically, with apperture downwards?

— Absolutely, although its position may be also slanted. But let us give our attention to the third case. It is most profitable of all, i.e., the rocket obtains the greatest speed, when explosion occurs as rapidly as possible.

— But, first of all, the speed obtained again will quickly vanish owing to resistance of air during crossing of atmosphere; secondly, relative weight inside the missile will increase so much that it will immediately crush any living bodies inside it.

— Further, — noted Franklin, — the cannon must be exceedingly strong, causing its weight to be excessively great, which is bad.

— True! I would consider that there would be sufficient pressure on instrument, 10 times exceeding weight of missile with all its contents. Here man will feel only 10 times heavier than usual. Such weight he can overcome easily with the help of means I have devised.

— I would like to know these means, — said Helmholtz.

— You will know them, — but not now... I will continue: the missile will move with increasing speed. By the end of the first second its speed will be equal to 90 meters and it will have risen to an altitude of 45 meters. After two seconds

its speed will double and the distance passed will be quadrupled. Allow me to write here a table signifying the time corresponding to the speeds and distances passed by the missile.

— I will do this for you, — Newton said and wrote in big letters on big black board three series of numbers:

Seconds......	1	2	10	30	100
Speeds.......	90	180	900	2700	9000
Kilometers...	45	360	4500	40500	450000

— Such intensified accelerated motion I do not approve, — said Galileo, peering at the table. Then continued:

— It is true, within less than a minute the missile will be already outside the limits of the atmosphere. However, it will lose much through outside its resistance. It is desirable, that initial speed, the speed in air, be as small as possible. Therefore, I will permit myself to offer here another table, as whose base will serve the tripled strength of gravity.

And approaching the board, he wrote a series of numbers:

Seconds......	1	2	10	50	100
Speeds.......	20	40	200	1000	2000
Kilometers...	10	40	1000	25000	1.00000

— In 50 seconds, — said the Italian as he finished writing, — the missile is raised 25 kilometers, where the resistance of atmosphere is extremely insignificant and speed of missile is still not very great. Emerging beyond the limits of atmosphere, it is possible to increase pressure of explosives and magnitude of acceleration; but in air it should be as low as possible.

— I am simply delighted! — exclaimed the Russian. — Your remarks not only prove your attention, but are also very businesslike. It is clear; I accept them with gratitude. Now imagine, — said the Russian after a silence, — missile

rushing to sky, at first slowly, then faster and faster; finally, it vanishes from view, it has left everything that is of the Earth...

Ivanov became unexpectedly silent, although everyone waited for the continuation. The lights were not turned on in the hall, and newly ascending crimson Moon illuminated it weakly. The Russian had fainted. Attracted by his idea, he had not slept for several days and had not eaten, driving himself to complete exhaustion. They turned on the lights; all were alarmed. Ivanov came to, but he was not allowed to talk, he was forced to drink wine and to eat something. All were extremely excited, but for the sake of their comrade did not mention the fact which agitated them the most.

It was decided to continue the discussion of this question, concerning all of them, on the following day; the Russian was delegated to Galileo, for supervision to force him to restore his strength and to sleep properly.

4. More About the Castle and Its Inhabitants

We will take advantage of the fact that all have gone off to sleep to say a few more words about our palace and its inhabitants.

Within two kilometers from it there was a waterfall. The waterfall activated turbines which in turn forced a dynamo to revolve giving off an abundance of electrical current. Current was conducted by wire to the small hill where the palace stood. There the electrical current illuminated all the rooms, produced chemical, and mechanical work in the workshop, warmed (when it was cold), ventilated, delivered water, and accomplished many other operations whose enumeration would be dull. Thus, with its help, there was concocted the supper which ended the day of our friends.

Beautiful was the castle at night from afar, illuminated by a great number of electrical lanterns. There it shone like a celestial constellation.

But by day it was even more excellent, with its towers, domes, and terraces.

In the mountains, illuminated by the sun, it produced a charming impression. It was far from ugly also during sunset, when all of it, it seemed, blazed with fire inside.

Wild nature surrounding the castle could not have harmonized more with the mood of its inhabitants. All these were disillusioned people, morally shaken. Some lost their wife tragically, some their children, some endured failure in politics and were witnesses of unpardonable lies and human stupidity. The proximity of city noise and people would only abrade their wounds. The grandeur of the surrounding mountainous site, the eternally shining snow-white mountain giants, ideally pure and transparent air, abundance of sun, — these on the other hand, calmed and strengthened them.

Well educated, long since world-renowned, they had turned into some sort of thinking machines and, therefore, had much common between themselves in general. Suffering and reflection weakened their sensuality and elevated their minds. The same science brought them together.

Their distinctions were not very characteristic: Newton was more of a philosopher and deep thinker — a phlegmatic person; Franklin had a nuance of practicality and religiousity. Helmholtz had made a great number of discoveries in physics, but was sometimes so absent minded that he forgot where his right hand was, and was more of a choleric person. Galileo was a delighted astronomer and passionate lover of the arts, although in his soul for some reason he despised his own passion for elegance. Laplace was for the most part a mathematician, and Ivanov was a great dreamer, although with vast knowledge; among them he was the thinker and more often than others raised those strange questions, one of which was already discussed in the passing day by our company.

Relations with the outside world were accomplished with the help of huge metallic dirigibles, lifting hundred of tons of load and moving with speed of one hundred and kilometers per hour and more. For small loads and few passengers they used airplanes.

5. Continuation of Conversation About Rocket

The following evening the Russian continued his report on his discovery.

— You saw that the missile in several seconds attains extremely rarefied atmosphere, and that in several seconds more it rushes into a vacuum. Considering the average pressure of gases, exceeding weight of missile with all its contents 10 times, we will find that in 160 seconds it will squander the whole reserve of the strongest explosives. Here it is lifted to an altitude of 1152 kilometer and will obtain the greatest speed at 14,400 meters. This speed is fully sufficient for it, to forever withdraw not only from the Earth, but even from the Sun. All the more easy we will reach any planet of our system. From all the facts presented, you, without doubt, see also the difficulty of such a journey. Air is necessary for breathing, but there is none to be had and no where to get it from...

— It is possible to take a reserve of air with us, although, indeed, it will quickly be exhausted, — noted the Italian.

— But sunlight with the help of plants can clean air spoiled by breathing, — objected Helmholtz.

— Nevertheless, — said the Russian, — this question requires deep and practical development on our part. Further, how will we return to Earth or how will we descend on another planet? Without a special reserve of explosives it is impossible to conduct this safely.

— For a long time I have conducted experiments with energy of explosives, — said Franklin, — and I think that I can manage to reduce many times their mass, replacing the known explosives with ones, discovered by me.

— I wish you success, — noted the Russian. — Only together can we reach practical fulfillment of our plan.

— In any case it is excessively risky, — said the careful Newton, — you forgot also about eating. Without food and water you will not travel far.

— To begin with, — objected Ivanov, — I do not anticipate long journeys. For instance, for passage to the Moon and back a week should be enough. Thus, the question of food, at least for the beginning, is not important. A reserve of several kilograms of food and drink would not be difficult to take.

— Thus, gentlemen, — summarised the Russian, — we will toil jointly over details of project, and then we will produce experiments of rising beyond the limits of atmosphere to some 500 - 1000 kilometers.

— Later we will expand the limits of experiments, — noted Laplace. — I would not even mind to be the first to fly, if only all will be arranged to perfection and the experiment in my eyes will not present danger.

— Oh, in such a case no one will refuse! — smiled Franklin.

— We will all fly with Laplace, — friendly voices were heard.

— And in the meantime, — noted the Russian, — before the trip, it would behoove us to restore to bright colors the picture of our journey...

— I love the sky so, — interrupted Newton, — that I will be very happy if the company will allow me during our rest in the evenings and during general conversation to read a number of lectures, which others in the castle desirous of listening could also attend.

— Excellent! We assign this to you. You will be the initiator of our astronomical conversations, — exclaimed the crowd unanimously.

— But you must not forget that before you, there are not only scientists: do not forget that in the castle there are many who will wish to listen to you; some of whom do not know how to distinguish a star from a planet.

— Yes, yes. Let's make your lectures one not only lively, but also popular, — said the Italian. — Perhaps I too could help you...

— And I, and I. — exclaimed the others.

— Thank you, gentlemen, — answered Newton.

— By day we will work, — said Helmholtz, — and in the evenings we will

delight in the anticipation of the unheard-of and the unprecedented.

— When we arrive at favorable results, then we will designate a special meeting, — noted Franklin.

6. Newton's First Lecture

The following day, at sunset, all again gathered in the round hall. Besides other persons also filled the hall, wishing to listen to the lecture.

Five of the scientists were seated around the table; the others sat on soft sofas against the walls. Newton began.

— The planet on which humanity lives has the form of a sphere whose circumference is 40 thousand kilometers. A man traveling 40 kilometers daily, would need a thousand days, or nearly three years, to walk around the Earth.

— Present speed of steamers and railroads, — noted Franklin, — allows us to reduce the time of a round-the-world journey by 24 times. Actually, now on the average it is easy to make 40 kilometers not in a day, but in an hour. Then we will travel around the globe in 42 days.

— But what holds up this gigantic sphere? — exclaimed one of the workers.

— This sphere, — answered Galileo, — does not rest on anything for nothing is not assumed and does not touch anything; it rushes in ethereal space like an aerostat, attracted by winds.

This sphere is a double magnet. First magnetism directs magnetic needle, and the second magnetism we call gravity; this is what holds in place all the objects, which are scattered on its surface; oceans, air, and people. If it were not for gravity, air, in virtue of its ability to expand, would have long ago flew away from the Earth. And also it would simply have to jump, and he would forever depart from it and to be made a free son of the ether...

— What is this ether? Is it actually the one we have in the pharmacy? — asked, smiling, another of the workers.

— Oh, no! This is similar to air, but strikingly elastic and extremely rarefied, — noted Helmholts. — The essence of ether is mysterious enough.* This is that all-filling medium, in which light propagates. Due to it we see near and far objects, sufficiently illuminated and large. Without it we would see neither the Sun nor the stars...

...If one were to place the people next to each other at a distance of a meter from each other, then they would encircle the sphere of Earth 200 times.**

— Is that all! But after all there are about 5 billion people, I think? — asked someone.

— Absolutely true, — said Newton, — and hence you see the vastness of the Earth with respect to man, which accurately judges the grandeur of nature with respect to one's self...

— If humanity were distributed evenly over all the Earth's surface, in cold and warm countries, on sea and land, then we would see that each subject would be at a distance of more than a thousand meters from another. At this distance they could hardly talk conveniently. Still more striking is the quantitative nonentity of humanity: if you will imagine that all its collective mass is turned into powder and scattered evenly all over the globe, then the thickness of this powder will constitute about 1/23,000 of a millimeter, i.e., the layer would be a thousand times thinner than cigarette paper.

— The least breeze would be sufficient, in order to blow away, — exclaimed one machinist.

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*Certain scientists even negate deny its existence. See also K. E. Tsiolkovsky, Kinetic theory of light (Density of ether and its properties). Publication of Kaluga Society for Study of Nature and Local Region, 1919.

**The beginning of the tale was written 20 years ago. Then I changed its plot, removed events by 100 years, brought up the population to 5 billion; some incoherence occurred which I failed to correct. (Note of author, circa 1927, [Russ] — Edit.).

— This beautiful Earth — the heritage of Man, — interrupted Galileo. — but if someone said to you: Go and inspect your whole possession... What do you think, how much time would it take for that?

— We do not know, — voices were heard.

— If one were to inspect land above, which is about 1/4 of all the earth's surface, and use for inspection each hectare but 1 second, even also then there would be needed 400 - 500 years!

— And I thought that you couldn't traverse all of Earth even in a lifetime, — said one foreman.

— You did not err. But how great is the mass of Earth or its volume? If someone rolled the globe into balls of equal magnitude and gave each human including, of course, infants and women, one such ball, then what do you think, what would the size of such a ball be? — Newton asked.

— Without doubt, a sizeable, — answered one of those attending.

— Oh, this would be a whole planet, — said Laplace, — 11 2/3 kilometers in diameter.

— Its surface, — added Newton, — would equal 380 square kilometers...

— Yes, this would be a whole German principality, — noted the Russian, — and one would have plenty of space in it!

— There is still another method, — continued Newton, — to imagine the minuteness of man in his relation to the planet: imagine that it and all beings on it are decreased by an identical number of times, for instance, 10,000 times; then on the sphere, now 1260 meters in diameter, we will see a pygmy some 1/5 millimeter in size. And this will be a tall inhabitant of Earth.

— Thus, — added Helmholtz, — he would drown in a sea, with the depth of a sand grain...

— The atmosphere would be 20 meters in altitude, and the highest mountains — only 85 centimeters. The depth of oceans would be somewhat more.

— However, this is sufficiently noticeable, — said someone.

— Take a smaller scale, — and you will not notice either mountains or oceans, — objected Galileo. — Imagine the Earth as a ball 12 1/2 centimeters in thickness, and highest mountains, and deepest sea will appear on it already as unevenness of 1/10 millimeters, no more. Such an unevenness is equal to the thickness of writing paper.

— So our globe is not badly ironed out, — cracked a lathe operator.

— Yes! — answered Newton. — If one were to withdraw from Earth so far that it appears as a ball of 12 1/2 centimeters.

It was late; therefore, it was decided to part till the following evening.

7. The Second Lecture

When the population of the castle met for their evening conversation, the sky was especially clear. In spite of the fact that hardly an hour passed since sunset, the skies glittered with stars; there was no Moon, it would rise late.

— Look, what a great number of stars! — said the Russian, indicating to the sky, excellently visible through the well-polished glass of the dome.

In good weather part of ceiling could be opened, which was done now, and a wave of pure mountain air carried pleasant coolness after a hot day.

— What are these, in essence, these stars? — a man's voice was heard, directing glances upwards.

— We will talk first about the Sun and Earth, — Newton said, — and then will understand what stars are. From the preceding lecture you imagined rather boldly the greatness of the Earth. Now I will endeavor to give an idea also about the dimensions of the Sun. The Sun is a fiery sphere from which it is possible to create 1,280,000 fiery balls the size of the Earth.

— Some balls! — noted one of the listeners.

— But why does it seem so small? — asked another.

— Because it is very far from us, — said Galieo. — Its distance from Earth is 150 million kilometers.

— And at such a distance it can heat so strongly! — someone was surprised.

— Here there is nothing surprising, when you take into account its dimensions,— answered Newton. — Its diameter is 108 times greater than the diameter of the Earth. Thus, if one depicted the Earth in the form of ball 12 1/2 centimeters in thickness, then the Sun should be depicted as a sphere 14 meters in diameter. This is a whole five-story house! In spite of the difference of size Earth and Sun, in essence, are almost the same...

— You, however, are already too... — involuntarily interrupted Galileo.

— I know, — said Newton, — the listeners did not quite comprehend.

— It is actually not comprehensible, — confirmed one of them. — The Sun is an inconceivably incandescent great blazing mass, and the Earth a comparatively tiny dark and cold ball...

— So indeed, but not quite so! — noted Newton. — That's the thing, this little ball is still terribly hot inside. There was a time when the Earth glittered and burned like a small sun, and maybe there will come a time when the Sun will cool and will be like the Earth.

— Save us, good Lord, — signed the listeners.

— The Earth is a small cooling sun, but the Sun is a huge Earth, still not cooled off, due to its huge size.

— Could this be possible? — exclaimed the listeners.

— Not only possible, but also absolutely obvious, — stated the lecturer. — First of all, the Earth even now has not lost its internal heat; secondly, — what is the soil, what are granites on which there are disposed alluvial soils? These are all products of burning of metals, gases and metalloids. The Earth is covered by ashes and is composed of ashes. Ashes indicate a great fire whose arena was the Earth... Gases burned the purest metals and metalloids burned.

— And the actual water of oceans, — inserted Galileo, — is only a product of gigantic burning of hydrogen in oxygen. Everywhere ashes: stones are ashes, water is ashes, mountains are ashes. The remainders which are not products of burning — are insignificant. There are such, we will say, but they are hidden in the depth of Earth, inaccessible to us: man tries to extract from the inherited ashes a burning inheritance. He obtains gold, silver, iron, aluminum, and many others for his needs. But how insignificant is what he extracts!

— Regarding, however, the Sun, — continued Newton, — it will burn still for a very long time; however, already even now on it there appear huge cinders. The size of the globe, and many scientists think there sometime will be an end to the Sun.

— But this is terrible. When will this happen?

— Death of Sun will come not earlier than in several tens of million years...

— Oh, — the crowd calmed down, — this means neither we nor our children need fear...

It had darkened quite a bit, the atmosphere was pure, and infinite number of stars were scattered above.

— These stars which you see, — said Newton, — are the essence of the sun.

— But the sun is great, blazing, not yielding to that star upon which depends all organic life of our Earth.

— And I thought that the Sun was the only one, — said one locksmith naively.

— If you had bothered to count the stars, then you would not have counted more than 5 thousand suns.

— Why then, when in the dark night one peers into the sky, the number of stars seems infinite? — asked the listeners.

— Some sort of instinct indicates to man the innumerability of stars which is partly justified, — said the Russian.

— Indeed, — continued Newton, — the better the telescopes we have for

inspection of stars, the bigger will the count of them be. In the best of telescopes one counts up to 200 million stars...

— 200 million suns! — repeated the crowd. — such a great number!

— In order to have a clear idea about this number, we will imagine that instead of each star, which we see with naked eyes, there are 40,000 suns, i.e., in eight times more than we can count directly on both hemispheres of the sky.

— On a small section of celestial dome occupied by the Moon, — said Laplace,— it will be necessary then to plant 10,000 stars, of which each one is a distant sun!

— Look, — said one of the machinists, — what a bright red star; here it is probably, a gigantic sun!

— Well this is Mars! — noted Galileo. — An insignificant planet, similar to Earth. This one of the tiny, cooled off suns; it is customary to call them planets. It gleams not by itself, like fire, but only due to the day, which reigns there and is presented to it by our Sun. Its light seems stronger than the stellar light, due to its extreme nearness to the Earth: some 70 million kilometers separate it from us — this is nothing in interstellar spaces.

— And are there many such planets between the real suns? — asked someone sitting by the wall.

— With the naked eyes it is possible to see on both hemispheres of the sky seven of them, and in telescopes, more than 600. Largest seven are called planets, the others planetoids.

— Is it true that there are so few? — someone was surprised. — With such a great number of suns this is somewhat strange.

— You forgot their small size and darkness, — said Galileo. — And here is the reason why we count so few of them. Only planets the closest to us are visible, those belonging to system of our Sun and moving around it together with the Earth, which is the eighth biggest planet of the Sun. If our Sun has more than 600 planets, then, without doubt, and the other suns must also have planets; but how can they

~~be seen,~~ when these suns themselves, due to their terrible remoteness, are barely visible blinking asterisks. The great majority of them are not to be seen.

— Because, — said Galileo, — for each sun on the average there are not less than 600 planets, — because our Sun is no better than the others, — then the total number of all planets will be not less than 80 billion.

— Thus, — noted Laplace, — each man could receive as a gift 16 planets, among which certain are greater than the Earth.

— But who will guarantee that we with our weak eyes and our insignificant devices see all the stars that are actually existing? If we see 200 million suns and suspect the existence of 80 billion planets, then what is the number of invisible suns and their planets to us?

The population of the castle used the French language for their communication. At first, because of the common language there were many misunderstandings, but at last it was decided to take that one which would appear the shortest and the simplest. Such, after an investigation, turned out to be French. Then the unpronounced letters were discarded and phonetic method of spelling was accepted, i.e., all was written exactly as it was prononuced.

8. Two Experiments with the Rocket Within the Limits of the Atmosphere

The lectures were interrupted for a certain time, because our scientist — friends too were swept up by the project of the Russian.

Franklin invented an explosive one hundred times more effective than the existing one, and from his laboratory there were constantly heard explosions, some shrill hissings and wild whistles, scaring the peaceful inhabitants of the castle. Newton and Laplace continuously produced calculations and, showing each other abundant numbers of figures and formulas, mysteriously and triumphantly whispered, and sometimes and shouted fervidly, as though in quarrel. Helmholtz resolved questions

about conditions of existence in ethereal space and worked on the system of breathing and food supply.

The Russian, conferring with first one and then with another, drafted designs of missiles and [plans] of journeys. Galileo was delighted and together with Ivanov tried to construct a model of a celestial coach, but did not quite successfully; therefore, from models he again returned to plans and calculations, from plans and calculations to realization. So the months passed. They met every day in the glass hall, but the public was not allowed.

At last, the group of scientists, apparently, came to a favorable conclusion, because something unusual was started.

In the workshop the work was going full speed ahead: something strange was constructed, apparently, it was the instrument, which our friends planned to visit the Moon. It was decided to produce the experiment at first in the high shed. The motions of the missile were limited by frames. We will go together with our friends into the lighted shed and will look at their instrument and experiment.

Instrument had the form of a metallic, vertically standing elongated fish bubble 20 meters in length. Horizontally it measured 2 meters. Inside the instrument there was sufficient light, due to many windows of small size. There we will see the three narrow pipes, proceeding on its walls and outgoing below to the outside. Further there were some mechanisms partly hidden by metallic housings, huge sections with some sort of suspicious liquids. In mixing them there occurred a continuous and uniform explosion, whereupon products with severe force should burst outside through the pipes in the lower part of the missile. A number of handles for intricate dials were designed for control of missile: for its motion in one or another direction, with one or another force of pressure of explosion. The remaining ones we will describe as the need arises.

Franklin, the Russian and Galileo entered the instrument, but Laplace, Helmholtz, and Newton stood at a respectful distance, looking now at the timepiece, then at the instrument. There resounded an explosion, then a uniform deafening

rumble; the instrument trembled and was lifted as far as the frame and chains permitted. The spectators outside yelled out with shining eyes, but exactly what was impossible to hear because of the noise. In 10 minutes those sitting inside congratulated by telephone their comrades with success, but continued the experiments. Thus the missile was suspended still for 10 minutes and then slowly descended. Ivanov and Franklin emerged and quietly rushed into the embrace of friends. The Italian did the same, stating that there was expended only 1/100th of all explosives taken for the experiment.

The following experiment regarding the controllability of missile had to be made publicly, because it was inconvenient to conduct it in the limited space of the hangar.

It was decided to place the missile in the yard and thus to observe its maneuvering. This time in the apparatus there were settled the Englishman, the German, and the Frenchman. The people stood nearby, not approaching the low fence, which shone in the Sun like a mirror surrounding the missile. Many did not know for certain why it was built; they thought that [it was intended] only for meteorological studies in the highest layers of the atmosphere.

The three friends sat inside the missile on easy chairs and tensely waited the agreed hour for flight. Helmholtz shivered slightly; all, because of agitation, were quiet. Newton was in charge of the force of explosion and pressure of gases and held the corresponding handle; Laplace watched over the direction, and Helmholtz watched over all and was ready, in case of need, to replace any of them.

The long awaited moment arrived, and Newton lowered the handle to a known figure. Laplace had adjusted his long ago, and the missile started extremely slowly into its ascent.

— Gentlemen, the missile is excellent, — said with a joyful sense Helmholtz, trying to control himself. — We have lifted to 100 meters... Now stop the motion!

Newton moved the handle again, and the missile became almost motionless, but the gases continued to burst with great force. After several seconds Newton proposed to

accelerate the upward motion, whereupon the apparent weight inside the instrument should double, i.e., each would weigh from 8 to 10 poods. From preliminary investigations they were convinced of the safety of such experiments. The comrades did not contradict, but settled more securely in their easy chairs. Newton touched the handle. Everyone became pale and almost fell through the easy chairs.

— Gentlemen, its hard for me, — implored Laplace after 20 seconds. — Enough, please, enough! — he beseeched, comically collapsing into soft easy chairs. The experiment was halted, for which Newton had to move the handle of the device by a hand which was becoming heavy. Feeling well, everyone involuntarily got up and looked through the windows.

— However, the devil knows to where we flew, — said Helmholtz with annoyance. Really, the castle with its additions could hardly be seen.

— Not the devil knows where, but only 2 kilometers away, — noted Laplace, glancing at the barometer.

— We could be lifted up to 1800 kilometers in 10 minutes, — said Newton, — if we took precautions regarding breathing. And now we should immediately think about returning, otherwise in several seconds we will be dried up in this rarefied atmosphere, because the missile now moves with a speed of 200 meters per second.

While Newton talked, they had risen still another kilometer and actually began to suffocate. But Newton ceased the detonation of liquids. Everyone's weight turned to zero, each began to weigh less than a dust particle. Phenomenon was quite curious, but since they continued the flight upwards by inertia and suffocated more and more, they didn't have time or mood to observe. They were lifted up still another 2 kilometers, the missile stopped undecidedly and began to drop exclusively by the force of gravity. Absence of gravity continued in the missile, but in 20 seconds its descent was decreased, and still in several seconds by means of detonation the missile extremely slowly descended to its stand in the yard of the castle. In these 20 seconds intensified weight again pressed them to the easy chairs.

9. Again an Astronomical Lecture

The triumph of our scientists was complete.

Now they waited to accomplish the flight beyond the limits of atmosphere.

Joyously it was decided to meet in the round hall for the reading of the third lecture and a report to the public about the new missile for flight into ethereal space.

Describing the missile briefly to the society, Newton said,

— Now, when we have hope of possibility of traveling in interplanetary space, we should be especially interested in data on astronomy. In the preceding lecture we saw that the visible world of stars or suns contains no less than 80 billion planets. In our solar system alone we, with the naked eye, count more than 600 planets. In view of forthcoming travel it is necessary to pay attention to the distance of planets from Sun and from the Earth. Will we master these distances? Will even a human lifetime suffice to conquer them?

— The celestial body closest to us, — continued Newton after a pause, is the Moon.

— The Moon — is the baby of the Earth, as the Earth together with six hundred other planets — is the baby of the Sun... Earth and the large planets are also daughters of the Sun.

— It appears that the Moon is the granddaughter of the Sun — pronounced one of those present.

— That's so, — agreed Galileo. — But the Sun has still other granddaughters, these are the Moons of the planets. Thus, Jupiter has eight moons — eight daughters, — and all of them are the granddaughters of Sun, as is our Moon.

— We will talk about the Moon, — said Newton. — Its distance to Earth is 380 thousand kilometers; flying in our celestial carriage an average of 5 kilometers per second, we will reach the Moon in 76,000 seconds, i.e., in less than twenty-four hours...

— There ascends the Moon, — said one of the listeners. — Probably, it is possible to travel to it also with the help of an aerostat or an aircraft...

— Yes, — said the Russian, — if only the air reached to the Moon! But even then it would take for this 1000 days, i.e., nearly three years because in air it is impossible to move as fast, as in vacuum.

— Atmosphere, — noted Laplace, — encircles the Earth similar to an orange rind, i.e., in size, it is comparatively insignificant. This is the light air clothes of the Earth.

— Atmosphere spreads, — continued to explain Franklin, — to altitudes of 300 kilometers, but already at altitude of 10 kilometers it is so rare that man cannot breathe it and inevitably dies.

The greatest altitude of atmosphere is not more than 1/1000 part of the way from Earth to Moon and, of course, cannot serve the Moon as aerostat.

— Is that so! — pronounced the same listener. — And it appeared to me that not only the Moon but also the stars soar in our air...

— Oh, stars are too far from us! — exclaimed another of the listeners.

— Yes, — said Newton, — the closest star to us is our Sun, but it also is 150 million kilometers away from us. How far do the other suns have to be if they appear to us as hardly blinking asterisks, in spite of their light force exceeding the force of the Sun?

— Flying on our missile 10 kilometers per second, — said Franklin, — we will reach the Sun in 15,000,000 seconds, or less than one half year. To planets of our Sun the way is measured by years and seems fully possible on our missile, if one were not to take into account the other difficulties besides the time.

— But to planets of other suns, — pronounced Helmholtz, — we could not reach them alive... for that a human lifetime will not suffice.

— Truly, — said the Russian, — to the second nearest sun to us, which is in the constellation of Centaurus - alpha, there are counted 38 billion of kilometers.

In order to travel such a way, even with the speed of 100 kilometers per second, which is possible, would require 12 thousand years. If a large group departed, only the four hundredth generation would arrive at this sun.

— What a pity, — exclaimed Galileo, — that those 80 billion planets, regarding which Newton spoke, turn out to be forever inaccessible to us.

— Yes, — said Ivanov. — But do not forget that the race is immortal and 12 thousand years for it are trifles. Thus, while those suns and their planets are not our heritage, then they may be the heritage of humanity in general.

— Nevertheless, — objected Newton, — Sun with its planets and their satellites are for us more important, because we can visit them, while about other suns with their planets we can only dream... Here is the planetary system in a form reduced to the scale of one billion (1/1,000,000,000). We will imagine a fiery sphere with a diameter of 139 centimeters: this is the Sun. Around it in approximately the same plane and in one direction are planets with their moons. The nearer to the Sun, the faster they rotate. The faster of all and the nearest of all to the Sun is the planet Mercury. According to our scale, this ball, is 5 millimeters in diameter (a small pea), is at a distance from the Sun of 58 meters. Further there follows Venus, in the form of a ball with a diameter of 12 millimeters (a forest nut). Its distance to the Sun, decreased by a billion times, will be 105 meters.

— Look at Venus, — interrupted Galileo, indicating to the west, where a bright star shone in the beams of still not quite expiring dawn.

— Not one star shines as strongly as Venus, — noted Laplace.

— Once I saw it even by day, in the full light of the Sun, — said Franklin. — And Mercury and Venus are to be seen either to the west or to the east. Mercury is more difficult to see, because it is very near to the Sun and sets immediately after the solar sunset.

— We will continue, — said Newton. — Beyond Venus we will see the Earth, distant from the central body by 148 meters — a nut with diameter of 13 millimeters.

— What is this! You have almost leveled the Earth with the other planets, — noted one of the listeners.

— I did not humiliate the Earth, — answered Newton, — nature made it so. Thus we saw that Earth, nevertheless, is greater than other planets. The subsequent planet — Mars — is in the form of a pea with a diameter of 6 1/2 millimeters. It moves slower than Earth because it is located further out, namely at a distance of 227 meters... Look! There is a bright red star in the east; it has already risen high enough. This is Mars. He has two satellites — quite insignificant dust particles, not depicted by our scale, which circle around it at great speed and at the same time move with their planet around the Sun.

— But you forgot to tell about the terrestrial Moon, — noted Laplace. — The Moon is the most accessible to us and, therefore, is the most interesting. During our journey from it we will start real survey of celestial bodies!

— True! True! — agreed Newton. — Our Moon — this is a millet grain of 3 1/2 millimeters, distant from the Earth by 38 centimeters. It rotates around the Earth and moves together with it around the Sun, as do other planets with their satellites.

— Beyond Mars we will see, — said Newton, — still more than 600 planets in the form of tiny poppy grains and dust particles — all types, but of very small dimensions; they are placed tightly enough which does not hinder them in complete coordination, i.e., to accomplish their way around the Sun in one direction. Beyond this planetary swarm there moves the largest of planets — Jupiter, in the form of a very big apple or even a melon, with a diameter of 14 centimeters. Here exactly the Earth becomes indeed as if ashamed, because from Jupiter it is possible to make 1390 such balls, as Earth.

— This is a more solid planet; by our scale it will be at a distance of 750 meters from Sun. It has eight satellites the size of millet and poppy grains.

— Only the nearest ones, — noted Laplace, — is a real dust particle.

— On this planet, — said Newton, bowing to the auditorium, — allow me to complete my narration.

The lecturer was thanked and everyone parted with wishes for good dreams.

10. Preparation for Flight Around the Earth

But the lectures were not destined to be continued: our scientists were so attracted by their celestial coach that they completely lost the desire to illuminate their audience with knowledge of the sky. They decided as soon as possible to accomplish the flight beyond the limits of atmosphere. The missile was closed hermetically and filled with only oxygen (without nitrogen) with a density of 1/10 in relation to air, i.e., twice rarer than atmospheric oxygen. Under these conditions it was excellent to breathe and also there was no excitation, similar to that which occurs from intake of oxygen of equal density with air. Furthermore, due to small internal pressure of gas it was not necessary to make walls of missile very thick. It was planned to take a great reserve of substances, from the combination of which there was obtained oxygen. Carbon dioxide and human miasma were absorbed in the missile by alkali and other preparations, which thus constantly cleaned the atmosphere of the chamber spoiled by breathing.

For breathing each man requires about 10 kilograms of these substances per twenty-four hours.

Since in the unusual conditions of flight it was easy to be taken aback and to fail to execute that which is required for the control of the missile, it was decided to construct an automatic controller which in its time will move both handles and give the missile one or another direction and speed.

Being prepared for the journey, by general consent the following was registered on the automatic device. The missile flies parallel to the plane of equator at an angle of 25° horizontally in the direction of rotation of Earth; during the first 10 seconds its speed increases rapidly to 500 meters; then, during the whole time

of passage through atmosphere it is increased much slower, by measure of rarefaction; after passage of air blanket of Earth the speed again should increase rapidly, and direction of motion gradually should be changed and at altitude of 1000 kilometers should become circular, whereupon speed should be so great that the missile would rotate around the globe along the circumference, not drawing near to it. It is understood, all actions of automatic control can be stopped or changed.

11. Eternal Spring. Complicated Rocket. Assembly and Supplies

A great deal of time passed, there was much work, many experiments and still more failures. Especially much time was expended on improvement of injector — instrument, charging two liquids, mixing of which gave an explosion. Temperature was terribly high, and it was necessary to find suitable materials, refractory and, at the same time strong. Simple pumps turned out to be suitable, since they required great work for motion and, therefore, — a nonexistent motor power. It was possible to stop only on similarity of steam-jet pumps (injectors) Zhiffara. Here the work occurred directly through force of exploding substances. It was impossible to manage without an injector, as in ordinary rockets and their facsimile used up till now. In them the pressure of exploding gases was transmitted to storage tanks of elements of explosion. This forced the tanks to be very strong, with thick walls, and terribly heavy. When the supply of explosives is small, then it is possible to rise and to fly even with heavy vessels; with huge loads of exploding substances it is necessary to release the vessels from terrible pressure, to make them light, which can be done only with use of pumps or injectors. During the first experiments one got along without them, but then also the flights were not significant. Also it was necessary to find suitable materials for the pipes, shells of rocket and other of its parts. There was a lot of bother also with controllability, with adjustment of the temperature, the medium for breathing, etc. Finally, it was resolved to depart beyond the atmosphere, around the Earth. The lavish climate of

tropic countries, very burdensome on large continents, in valleys, low above sea level, is turned into eternal spring with coolness, sun and constancy at altitudes of three or four kilometers. Neither summer nor winter was noticeable here. Such was the site of our hermits. With abundance of light, a great number of clear days, dryness of air, its temperature was not only constant, but also 10 - 15° lower than at sea level. In the daytime in the shade it was 10 - 20°, at night it decreased significantly. But at night one rarely works in the open air. One worked then in closed locations; it was not cold there. Thanks to this unchanging spring one worked in the shade of trees or in the shade of canopies the whole year round. But it was necessary to guard against the sun; it was stronger than in low valleys and more frequently produced sun strokes.

From a simple rocket they went to a more complicated one, i.e., composed of many simple ones. In general, this was a long body, form of least resistance, in length 100 meters, 4 meters in width, something like a gigantic spindle. Transverse partitions divided it into 20 sections, each of which was a reactive instrument, i.e., in each section there was contained a reserve of explosives, there was a combustion chamber with automatic injector, combustion tube, and so forth. One middle section did not have a reactive instrument and served as a wardroom; it was 20 meters in length and 4 meters in diameter. Injector was designated for continuous and uniform pumping of elements of explosion into detonating pipe. Its construction was like a device of Zhiffara steam-jet injectors. Complexity of rocket missile was attained by its comparatively insignificant weight in connection with huge useful lift. Combustion tubes were curled spirally and gradually expanded to the outlet. Some windings were located across the length of the rocket, others — lengthwise. Gases, circulating during explosion in two mutually perpendicular planes, gave great stability to the rocket. It did not wobble like a badly controlled boat, but flew like an arrow. But expanded ends of all pipes, emerging

outside from the side of rocket, were all almost in one direction and were all facing one side. Number of outlets constituted a spiral line around the instrument.

Chambers of detonation and the pipes forming their continuation were constructed from very refractory and durable substances, like tungsten, as were injectors. The whole explosive mechanism was surrounded by chamber with evaporated liquid, whose temperature was, therefore, sufficiently low. This liquid was one of the explosive elements. The other liquid was placed in other isolated sections. The external shell of the rocket consisted of three layers. Internal layer was of durable metal with windows of quartz, covered with another layer of ordinary glass, hermetically sealing with doors. The second layer was — refractory, but almost not conducting heat. The third, external layer was a thin metallic refractory, shell. During swift motion of rocket in atmosphere the external shell was heated until white, but its heat was radiated out into space, not penetrating strongly inside through other shells. Cold gas continuously circulating between two extreme shells and penetrating the light, small heat-conducting medium lining, also hindered this. The force of detonation could be regulated with the help of complicated injectors; it could also be halted and started over again. With these and other methods it was possible to change the direction of the axis of the missile and direction of detonation.

Temperature inside the rocket was regulated as desired with the help of cocks, passing cold gas through the middle shell of the rocket. From special reservoirs there was separated the oxygen necessary for breathing. Other missiles were designated for absorption of waste products of given off from the skin and lungs of the humans. All this was also regulated according to need. There were chambers with reserves of food and water. There were individual pressure suits which were put on while going into empty space and upon entry into the atmosphere strange of a foreign planet. There were a great many of tools and instruments having known or special designation. There were chambers with liquids for submersion of travellers during intensified relative gravity. People immersed in them breathed through tubes connected with

the air atmosphere of the rocket. The liquid destroyed their gravity, no matter how great it was in short time of detonating. People moved all their members absolutely freely, not even feeling their weight, as it is felt on Earth: people were similar to people bathing, or to olive oil in wine during experiment of Plato. This lightness and freedom of motions allowed it excellently to control all regulators of the rocket, to watch the temperature, force of detonation, direction of motion, etc. Handles, led in to them in the liquid made it possible for them to do all this. Furthermore, there was a special automatic control on which for a few minutes there was concultrated all control of the missile. During this time there was no need to touch the handles of the instruments; they did themselves all that had been "ordered" beforehand. There were taken reserves of seeds of various fruits, vegetables, and crops for their cultivation in special greenhouses, released into the void. Also there were prepared the structural elements of these greenhouses.

The volume of the rocket was about 800 cubic meters. It could hold 800 tons of water. Less than a third of this volume (240 tons) was occupied by the two gradually exploding liquids, discovered by our Franklin. This mass was enough to give the rocket 50 times the speed rocket sufficient it to depart forever from the solar system and anew 50 times to lose it. Such was the force of detonation of these materials. Weight of the shell, or the actual body of the rocket with all belongings, was equal to 40 tons. Reserves, tools, greenhouses made up 30 tons. People and the remaining — less than 10 tons. Thus, the weight of the rocket with all contents was three times less than weight of explosive material. The space for location of people, i.e., filled by rarefied oxygen of space, constituted nearly 400 cubic meters. It was contemplated to dispatch 20 men on their way. For each there was allcted a volume of 20 cubic meters which, with constantly purified atmosphere, was to the highest degree comfortable. The 21 sections communicated with each other by small passages. Average volume of each section was about 32 cubic meters. But half of this volume was occupied with necessary things and with

exploding mass. There remained on each section about 16 cubic meters. The middle sections were larger, and each could serve as an excellent location for one man. One section in the thickest part of the rocket was 20 meters in length and served as a hall for meetings. On the sides of these sections there were located windows with transparent glass, closed by external and internal shutters.

12. Altitude of External World. Location of Rocket

The external world did not know about the intentions of our scientists; the newspapers were quiet; quiet were the scientists themselves. This occurred in [AD] 2017. But also then there were still secluded corners, backwoods, whence information penetrated little into the remaining world. Colleagues, masters, and friends of the scientists constituted the whole population of the colony, and they did not air private affairs in public.

Rocket was near the settlement, on a site slanted to the horizon by 25 - 30°. She was visible to dirigibles and airplanes, flying frequently near this site with loads and passengers. The same happened with experiments of Wright brothers, which were 100 or more years ago. Europe and the whole world believed in them only two years after, although people saw from trains the brothers flying the airplane; even the eyewitnesses were not believed.

13. The Farewell. Locked in the Rocket. Take-Off. First Impressions

Newton, Laplace, Franklin, and Ivanov, resolved to depart in the missile. They took still another 16 men, masters of the most important specialties for flight. All the inhabitants of the settlement escorted the travellers. For a considerable time prior to flight the crowd surrounded the rocket. The weather was excellent. Sun was shining full swing. But this was not a surprise, since such weather is usual here. Dry air, stimulating, and cold. The dryness of the location forced the inhabitants of the castle to resort to artifical irrigation

of fields, gardens, and kitchen gardens. There were many waterfalls and fast running mountain rivers. Their water was directed to the gardens and cultivated fields. The rocket was surrounded by excellent fruit trees, and somewhat further there rose majestic sequoias. After kind wishes, embraces, and enthusiastic shouts of the crowd, all the twenty men were locked inside the rocket. They themselves were hermetically sealed in, turned on the light of the electrical fixtures. Double shutters were closed. Each one plunged into the case with liquid intended for him and breathed through a tube. The members could freely move and operate the missile with the help of handles immersed into liquid. Newton operated the detonating force in tubes, Laplace controlled the motion of the rocket; he also eliminated destroyed any rotary motion appearing. Franklin was in charge of temperature and purification of air. Ivanov watched other trifles and everything in general. He could talk with his comrades by means of hearing tubes, just as the others could among themselves. The other sixteen could transmit their pretensions to only one of the masters, who informed Ivanov, if that was necessary. This time Ivanov was chosen the director.

— Gentlemen! — said Ivanov. — Shouldn't we start the flight? Is everything ready? Are you settled?

It turned out that all was in order and all were settled. The Russian moved the handle. This is not the first time he did this. There resounded explosions, which immediately became comparatively monotonous, deafening, howling sounds. But the ears of travellers were closed with tubes, plates, and layers of water. If it were not for these their ear drums could not stand it. The light of electricity penetrated through the small windows of the unique coffins, where our friends rested in liquid. But the "deceased" looked gay enough, very quietly looked around, examined the familiar walls of the rocket and cabinets and instruments fastened to them, which they themselves created.

— Gentlemen! — said Ivanov. — The relative gravity is ten times more than the terrestrial. Some of you now weigh 40 - 50 poods. Do you feel this? Don't your muscles ache, isn't it painful anywhere?

— Everything is fine! — Pleasant bathing! — Full rest! — Lightness as earlier! — Complete freedom of motions! Simply wonderful... — the reassuring and even happy voices were heard.

Several seconds pass.

— It is hot, the air for breathing is hot! — stated one of the stouter foremen.

Ivanov passed on the pretension to Franklin, and the latter, by motion of lever, accelerated the circulation of cold gas. The temperature dropped.

Several seconds more passed.

— It is cold. — complained someone.

This was also taken care of. All pretensions were satisfied: there was stale air from accumulation of carbon dioxide, then the rocket revolved along its long axis and the weak became dizzy... No one complained, when there was a surplus of oxygen. But it was not permitted [to remain], although it revived everyone — as intoxication is not allowed.

The detonating force was not constant, because economy of explosive materials, or stored energy, required strict sequence in pressure of gases, calculated beforehand to exactness. It was observed automatically. Thus the phenomenon of relative gravity by its force changed continuously; no one noticed this and could not note this owing to the liquid surrounding them, which was of the same density, as the average body density of each of the travellers. Only several things, insufficiently well fastened, broke off from the walls and fell onto the partitions, however, no one heard any noise in view of the general howling and rumbling of detonating.

14. The People Remaining on Earth. Lecture in the Castle

We will leave our friends flying, and ourselves will descend downwards to the inhabitants of the castle who as a crowd escorted the travellers. They saw how the rocket broke off and soared in a slanted position into space. Many were stunned from fright. All were deafened by the noise, but it rapidly faded away with the

withdrawal of the rocket. It rapidly departed eastward, in the direction of the motion of Earth around the axis. At the same time it rose higher and higher. In 10 seconds it was 5 kilometers from the spectators and moved with a speed of 1000 meters per second. It already was hardly visible in strong binoculars and then, because of air friction, it began to gleam. It is possible to say that it disappeared almost instantly from the eyes of the spectators. One heard as if the rumble of thunder. First it increased, then began to weaken. The thunderous rollings continued, although the rocket no longer could be seen. Crowd looked in different directions, but there were no clouds anywhere: this rocket cut through the air, which gave a thunderous air wave.

Helmholtz and Galileo invited those who wanted to come into the meeting hall, in order to rest and to converse.

The group sat as they wanted: some in easy chairs, some stayed at their places located in the amphitheater. They were refreshed by fruits and light beverages. There arose a rumble of voices. Much was said about the rocket and its passengers... They argued inspiredly, contradicting each other.

Galileo offered to talk. Everyone settled comfortably and calmed down.

— Gentlemen. — said Galileo. — I would like to explain to you what you will have to experience as travellers in your rocket. I heard your arguments: not everything was reasoned out correctly. Let us assume that for the rocket, — only the rocket and not the bodies in it, — there acts a constant force in one direction, as, for instance, pressure of gases during explosion. Gravity of Earth and other celestial bodies is at present nonexistent. The rocket under the influence of this force obtains evenly-accelerated motion, i.e., it will move with a speed increasing proportionally to the passage of time. Any body, closed in a rocket, but not touching it, will appear to be falling in the direction inverse to the external force effective on the rocket. Thus, all bodies in the rocket drop with even acceleration. Thus, it will appear. If, however, the floor of the rocket hinders this, the table

or other furniture, then the body presses upon it. And this is the apparent gravity, which according to its results does not differ from the gravity caused by planets. The magnitude of this apparent gravity is the greater the higher the speed, which is obtained by the rocket each second. Acceleration on Earth is about 10 meters. Even if the rocket would obtain from the external force each second the same speed, then in it there will be formed such gravity, as on the surface of Earth. If this per-second acceleration will be 10 times more, then the apparent gravity in the rocket will also be 10 times more than the terrestrial. The direction of this artificial gravity will be, as I already said, the reverse of the direction of the force acting on the rocket.

— Well, and what sort of influence should the Earth, Sun, and planets render on apparent gravity in rocket? — a voice was heard.

— To this I will now pass, — said Galileo. — We will consider, for instance, the action of terrestrial gravitation.

— Attraction of globe acts not on one rocket alone, but also on all bodies included in it. If the rocket will move somewhere under the influence of this all-penetrating force, then also any other body in the rocket or near it will move under the influence of this force absolutely the same way. The observer in the rocket will not see the difference between the motions of the rocket and the surrounding bodies. Hence, the influence of terrestrial gravitation cannot be revealed with respect to the rocket. The conclusion is such: not only the Earth, but also none of the celestial bodies can have influence on apparent gravity in the rocket, i.e., they can neither increase it nor decrease it. It is clear that this pertains to rectilinear, uniform and penetrating forces.

— Consequently, — said Helmholtz, — apparent gravity in our rocket depends exclusively upon the acceleration per second, obtained by it under pressure of exploding gases in its pipes. If this per-second addition of speed (or acceleration) constitutes 100 meters, then all the bodies in the rocket will be made 10 times

heavier than on Earth. Earth, Sun, and planets do not have any influence on the apparent gravity.

— From this still it is clear that when detonation ceases and rocket will cease to obtain acceleration from pressure of gases, — noted the Italian, — the relative gravity should disappear without a trace, in spite of any mighty action of the all-penetrating forces of gravitation. Then the travellers will dangle, so to say, in their atmosphere: they will not fall, nor press on floor and support either. They will be similar to fish in water, only they will not experience a huge obstacle during their motion, i.e., resistance of water.

— Interesting, an excellent state, — voices were heard from the auditorium.

— Here is a question, — said one of the listeners, — when the rocket will reach beyond the boundaries of the atmosphere, then external pressure on it will cease... Won't then, the elasticity of its internal atmosphere burst it?

— The strength of walls of the rocket can sustain pressure 100 times greater. Besides the rocket is filled with pure oxygen, 10 times less dense than air. Elasticity, this means, will be 10 times less than elasticity of air and twice less than the partial pressure of oxygen in the atmosphere of Earth. The pressure on walls from this also will be 10 times less than atmospheric. Why then will the rocket burst?

— Will the atmosphere be rare in the rocket and will this not cause bleeding? — said one master.

— Travellers already tested safely this atmosphere during experiments, — said Helmholtz. — But if it will appear unbearable to them, they can increase their gas medium by addition of nitrogen in whatever degree desirable.

— And here still... Temperature... — asked a very young man. — After all temperature of celestial space is close to absolute zero, or to 273° of cold by Celsius. What will happen here? Can people sustain this temperature?

— Temperature of space is determined by thermometer, — said Helmholtz. —

So that we will recognize, own, temperature of thermometer. If there are no radiating celestial or terrestrial bodies, then, certainly, due to uninterrupted loss of heat by means of radiation, the thermometer as any other isolated body, should lose all its heat and, this means, be cooled to absolute zero, or to 273° cold.

— It is unknown even then what would happen to the body, — noted Galileo, — maybe, its properties will be absolutely transformed, cohesion will be infinitely increased, perhaps, it will be strongly compressed or will even disappear...

— Yes — said Helmholtz, — it is difficult to imagine that will then occur with the body. But ether space is completely filled with vibrations of various kinds, mad motion of electrons and still with a great number of smaller particles of matter. These and others are emitted by stars, planets, the Earth, and ether itself. Thus in practice the motion of atoms of thermometer of other body cannot cease, all the energy from the body cannot disappear. Radiation of remote suns, or stars, and also planets we can disregard: with respect to the Sun it is insignificant. Our rocket with certain withdrawal from Earth is almost constantly subjected to action of solar beams. The question is, what sort of temperature can they give it?

— This depends not only upon distance of body to the Sun, but also upon form, color, motion, and other properties of body — said Galileo.

— Absolutely true! — confirmed Helmholtz. — Scientist Stefan found a law by which it is possible to resolve at least approximately the question about temperature of planets and other, even smaller bodies, during varied conditions, and limitations. Based on his investigations we can report the following. A plate, perpendicular to beams of Sun, at a distance of Earth, with one side covered with soot (turned toward the rays), and with the other protected from loss of heat, should be heated up to 152°. This is the greatest limit of temperature on Earth. On Moon one meets with such temperature. If we take a ball covered by soot and revolving, then its average temperature will be 27°. The same can be obtained for rocket with a black color; but it is understood, if one were to protect one of its sides (shadow)

from radiation and to give it the proper form, then temperature can be raised and can reach up to 152°. If the ball is not black and a noticeable part of the rays are dispersed into space, then the average temperature will be lower. Thus, with conditions on Earth, when 20% is dispersed, the temperature will be 13°. (Average temperature of globe, reduced to level of ocean, is equal to 15 1/2°.)

— This is all very well, — said one of the workman, — but how will the rocket be... at the distance, for instance, of Mars from Sun? Won't everything freeze there?

— And here we will answer you in numbers, — said Galileo. — If even the rocket will be twice further from the Sun than Earth, then even the limiting highest temperature for black plate will be 27° higher than zero. Protecting the shaded side of the rocket from radiation by various methods and opening access to solar beams on the other hand, we can attain 27°, then 20 or 15, which is sufficient. One can use also heating, but it unnecessary with the eternal, although weak, radiance of Sun. Really, we can increase temperature of rocket as we wish by reflection of solar beams on it with help of mirrors. There, in ether, metallic mirrors do not dim and do not bend from gravity, since there is none of it around the rocket nor inside it.

— Wonderful, excellent! We understand that cold does not threaten the rocket, but I do not understand, — said one of the young workers, — why the relative gravity in the rocket during beginning of detonating will not crush the travellers. You said that it would be increased, although not for a long time, by 10 times. This means, if I weigh 5 poods, then in the rocket I will weigh 50 poods. If my head weighs 7 pounds, then there it will weigh 70 pounds. After all, this is the same as if I were loaded with 45 poods. I couldn't stand it... Blood will be heavy, almost like Mercury. Blood vessels would rupture, hands will be torn off from gravity...

— But this after all is true!... — the rumble of voices was heard.

— It is true, — confirmed also Galileo. — But all our friends will remain safe and sound, because they are situated in a prone position in liquid of the same density as the average density of their bodies. You will believe this when I will show you this experiment. Do you see this figurine of a man? It is very delicately made, from a very fragile substance. I drop it and you see, — it is broken into several pieces. But I take another figurine, the same type and place it in a strong transparent sphere, filled with liquid of the same density as the figurine. You see it does not rise and does not fall, although I move the sphere every way. We will throw the sphere and smash it with a hammer... see: the figurine remains unharmed. I place this sphere on the centrifugal machine and by rotation increase the weight of the figurine, sphere and liquid by 100 times... Look, — the figurine is intact.

— The facts are, — interrupted Helmholtz, — it is this weight of liquid here that balances the weight of the figurine, so that part of it does not press another and the walls of the sphere; it even does not touch them.

— Density of parts of human body is unequal; bones, muscles, fat do not have the same density, — said Galileo, — therefore, there remains a certain stress among these parts which attains great magnitude with very huge relative gravity. But its magnitude increased by ten times rupture of tissue will not occur. Actually, we can produce the same experiment with living creatures: fish, frogs, etc. Gravity can be increased by 100 times... See, everything remained alive.

— Gentlemen! — exclaimed someone. — The animals are alive, but are our outer space travellers alive now? Are they healthy and where are they?

— Maybe, they are now flying past our castle.

Everyone involuntarily turned their glances toward windows and transparent ceiling.

— What kind of a star creeps eastward, not an aerolite? — inquired quite a young worker.

— Where? Where? — voices were heard. — and here it is! Look quickly at the Cassiopeia constellation.

— Gentlemen! — said Galileo, — this is not a meteor. It leaves a trace in the atmosphere and almost always disappears rapidly. This star does not leave a trace; furthermore, it moves much slower and, as you see, remains in the sky.

— Ten hours passed since the time of flight of our friends. During that time they should make six full orbits around the Earth. Obviously, we can see the rocket, illuminated by bright electrical light. Our friends are giving us a signal that all is well with them.

Hardly did Galileo say this than the star began to disappear and reappear at equal intervals of time.

— There is no more doubt, — said Helmholtz, — these are ours. Here they are signaling the alphabet by Morse code... They report that all turned out happily, that they are alive and well...

An unbelivable noise arose, joyful shouts were heard, celebrating speeches, arguments; eyes shone, chests were raised high... Thus ended this meeting.

15. In the Rocket Flying Around the Earth. Detonation Has Ceased. [The Crew Has] Emerged from the Water. A Discussion

Let's go back again to the rocket and we will look in to see what our friends are doing. We know that in their "coffins," flooded with liquid, they couldn't have felt better: they held discussions and freely moved all members. It was impossible, however, to remove a single organ from the liquid: it immediately became heavy and dropped, like lead, back into the liquid. Only when detonation weakened it was possible to do this. But there hardly passed ten minutes, as the adverse howling of the rocket ceased, it only rang in the ears.

— Detonation has been completed, — reported Ivanov and started to get out of his bath... All felt like travellers when the carriage has stopped unexpectedly. But it did not stop, but rushed on with a terrific speed; only the chemical reaction of combined liquids stopped. We did not feel like getting out of the water, like

one does not want to get up in the morning from a soft bed. The neighbors saw how the Russian disentangled himself from his box, how he flew several times to and fro in his section and, finally, grasped something; the liquid from the box also poured out and flew in regular spheres in various directions until it adhered to the walls of the rocket and did not run off there. Ivanov laughed and dried himself with a towel.

— Gentlemen, — said he, — now it is possible to arise! We have slept sufficiently long...

Our friends, moved by curiosity, got up rapidly one after the other and performed the same [vitual] as Ivanov. There was still a ringing in their ears, but laughter, exclamations and conversations muffled this nervous noise... They dried off and covered themselves in light clothes. They carefully gathered the liquid and poured it back where it came from. Everything was brought in order. Torn off clothing, circulating, roamed from corner to corner, from wall to wall, but quieter and quieter. They too fastened themselves strongly to their places.

The people gathered in the large, cylindrical middle cabin; like all other cabins, it was about four meters in diameter, but in length it was five times longer than the others, i.e., 20 meters. There was room for 20 men. Doors into the neighboring sections were opened. One after the other our acquaintances flew into the salon: some sideways, some with legs up, although to each it seemed that they were in correct position; some felt that they were motionless, and others, moving. It was difficult to be completely without motion; it was an unusual state and excited infinite wit, jokes, and laughter. The eyes were enlarged from fright, then from astonishment...

— Gentlemen, we will still have time to be amazed and to laugh. We will endeavor to calm down and to discuss own situation! — said Newton. — That is, not what you feel now, but your situation in outer space.

The meeting quieted down, but its members, actually not noticing, were gradually

snifting and pushing like fish in water; only the direction of the bodies was different. They listened attentively...

— Judging by time, — said Laplace, glancing at his timepiece, — we have flown beyond the limits of atmosphere. The rocket seems to us absolutely motionless, but this is an illusion; according to the previously calculated plan, which is carried out automatically by the controls, it should now revolve eternally around the Earth. Its position is very stable; it is at a distance of thousand kilometers from the surface of Earth and moves along a circle with constant speed of about 7 1/2 kilometers per second. It should accomplish an orbit around the Earth in approximately 1 hour and 40 minutes. Now we are similar to the Moon, because we have become an Earth satellite. We never will fall on it, like the Moon cannot fall on the Earth; its centrifugal force balances the attraction of the Earth.

16. Subjective State

— Gentlemen, we are simply motionless! — a desperate voice was heard. — We are absolutely motionless and are in that brightly illuminated devilish cellar. I cannot understand what is happening to me, and do not believe my motion, — not for anything...

— It seems to me that I am going out of my mind... — still someone else stated. — Everything circles around, nothing rests, we have become neither birds, nor fish; at least, those are situated horizontally, we — haphazardly... heels meet with heels, back of head with back of head... repeatedly one is forced to bump against a friend, although it is rather spacious here... I know that I lost relative gravity, but in no way did I assume that I would feel like I feel now... after all this is some phantasmagoria... here repeatedly the heart sinks, and seems as though you are falling as soon as you note that under you there is no support...

— Friends, calm down, — said the Russian, — we will gradually become accustomed to this magic and will consider it completely natural. Concerning your doubts,

they will disperse as soon as we open the shutters and look out on God's world. But it seems to me that it is necessary to wait with this: even now our state of mind is unnecessarily excited; what will happen when we will see the sky and Earth, — transformed, extraordinary... What can be simpler than this, but in practice again there will happen magic... Not all will sustain this impression unpunished. I will calm you down by the saying that Laplace already looked into the small window and was convinced that the rocket had become an Earth satellite, that our position is absolutely safe and that what happened was necessary and previously calculated.

17. Occupation, Sleep, Reading, Food

— Instead of burdening excessively the soul, — said Franklin, — wouldn't it be best to stay "home" and be occupied by something more innocent... Here it is light, warm, clean, good air, we are 20 men... We can read, slumber, eat, converse, can separate into our cabins; there are 20 of them besides this glorious hall... Let only the one on duty watch the temperature and normal state of air...

— True! True — voices from all sides were heard. — We will rest, retire alone, talk intimately...

And the inhabitants of the rocket scattered into their cabins: in pairs, in threes, alone. Cabins were illuminated and had individual conveniences. In order to move one had to push off from the walls; the motion was not quite even, many bumped against the door frames, and were repulsed from the frames and flew further; others adroitly flew through all the doors without touching one; only in their cabin they grasped the partition and were concealed in their room. Some turned off the electricity and fell asleep in the middle of the section; they were slowly, very slowly carried from one corner to another, due to involuntary motions in sleep. Even blood circulation and breathing had an influence on their motion and position. There were no beds, but no one rubbed their sides numb; it was warm, since everyone considered napping they increased the temperature of their cabins by several degrees.

It is possible to hide up to the neck in wool bag, — those who did not desire heat for their head... Others opened books and read... Light folding frame, if desired, embraced the body slightly and made it possible to remain motionless; thus it was more convenient to read by the lamp but it made no difference as to sleep. Those who preferred to rest in one position, could attach themselves by two chains to walls, or settle behind grid partition like that of a fish net. The book was easily held in the hands since it was weightless; the pages puffed up and it was necessary to hold them with a spring or simply with pins... Others chatted about past terrestrial matters to calm their nerves... reminiscing... and even, alas, regretting... There were some who even were wishing to be reinforced with food. In the rocket everything was arranged for drink and food. The usual procedure for this matter here was impossible: the dinner table would not stay on its place, nor would chairs; at the slightest shock all this will rotate and start moving from corner to corner; if one catches, and resets the furniture, again the same will happen! All the utensils, of course, should be screwed to the walls. But why do we need tables, when the dishes do not drop anywhere? What do we need chairs and easy chair for when man does not need to support himself and does not move, until one pushes him? What use are beds, spring mattresses, mattresses, feather-beds, and pillows, if it is soft everywhere even without them?.. Perhaps for the illusion of terrestrial life?. But all the same you will not remain in your easy chairs, will not settle in your beds if you are not attached to them! One has to attach plates, and carafes, and even the food itself. You will put a fork or a spoon on the table, but they will jump up and will fly to your neighbor: it will be lucky if fork does not poke someone's eye out and point of knife does not strike a nose! Everything should be fastened. Even the food is fastened. It will be strung by a thread or draw arcs, soil the table and physiognomy of his neighbor. The light, crumbly food will scatter in different directions during cutting, getting into the nose, into the mouth, in the eyes, and ears, in the hair, and pockets of neighbor. The neighbors will sneeze, cough, rub eyes, wash fat from face... You will want to pour a glass

of water, — the water will not pour out, you withdraw your head backwards in order to drink a glass of wine, but by inertia it departs from the wine glass in the form of several spheres and flies where it shouldn't; wets the beard's and dress clothes of the ones dining, gets into the mouth of ones who were not planning to drink...

Instead of easy chairs there can be light holders for those who wish to remain in one place; instead of tables — the same holders for vessels with food: similar to a light shelf with great number of places, from which it is easy to extract vessels with food or drink and to place it back — with fastenings. Thus, this was arranged in the rocket beforehand since the scientists expected almost all of this. Foods were sealed. Semiliquid or liquid substances for feeding were used, thus: fastened to the vessel by a pump, some air was pumped into it. The latter produced a pressure on the partition in the vessel in the form of a piston, under which there was food; from this the liquid strove to escape from a cock with a soft tube. The tube was put into the mouth and the cock opened for a moment. Semiliquid food entered the mouth and, with the help of the tongue and swallowing motions, went into the stomach. Solid and also semisolid food, like jelly or fruits, was held slightly on the plate by springs and nets. From it sections were cut, pierced onto a fork and dispatched into the mouth, which then managed it with the help of the tongue and teeth. Knives, forks, and other instruments have to be attached by short chains to the fastened plate or to its support.

18. Physical and Chemical Experiments. A Concert

The scientists offered to those who desired after rest to gather in the hall, in order to observe physical and chemical experiments in the absence of gravity.

— Sound, — began Newton, — as you see from our continuous conversations, spreads here absolutely the same way as in terrestrial atmosphere. Elasticity of gas concluded in the rocket was kept, and this means, also ability to oscillate...

— Shouldn't we sing something, in chorus for illustration? — noted one of those present.

— Excellent, — said Laplace, — one can also include music.

The group expressed consent. Musicians unhitched themselves from their machines, i.e., holders, and flew after violins, pipes, music. They returned immediately. This time the majority of them used the described machines in order not to turn and not to wander into all directions. The picture of the meeting was very decent. The musical director gave the sign, and chorus sang, accompanied by musical instruments. It seemed that they hadn't heard music for a long time — so gratifyingly it poured into their souls. Many forgot that they were not on Earth and, hanging in air, muttered sometimes something quite unsuitable to their place of residence. The concluding chord is sung. They shouted "encore" and applauded desperately. They repeated and sang several more things with the same success. At last, the musicians asked mercy.

— Thus, you see, — said Newton, — that sounds here are absolutely ensured. All acoustic experiments do not differ from any terrestrial...

— Here there is no gravity, — after thinking he continued, — of this terrestrial measured mass, but it here is especially well felt by bodies during report of motion. The more we experience, from the side, their resistance during their push off from the place, the greater their mass. The mass of any body is felt perfectly by the hand which is pushing it.

— But, of course, neither on springs nor on beam balance or ordinary scales can mass here be recognized. You see that these instruments do not work here: spring does not stretch, the balance beam of scales is in equilibrium with all loads and at all slopes. Mass here, nevertheless, can be determined by various instruments to full accuracy, for instance, by especially adjusted centrifugal machine. Mass is still indicated by stopping it by hand. The more difficult it is to stop moving bodies at the same speed of their motion, the more significant their mass. Dividing mass by volume, we will recognize density of body. Mass shows during its blows: it is proportionate to force of blow. But it is necessary to

pay attention to speed of mass. Small mass can produce heavy blow at great speed and conversely. Firing instruments are here still more active than on Earth.

— Motion here, — noted Ivanov, — is rectilinear, eternal, uniform, if one were not to consider resistance of air. The influence of Earth and other celestial bodies also shows, but in the rocket and at several tens of kilometers from it, it is not noticeable.

— Here is a mercury barometer, — said Franklin, — mercury rose and fills the whole tube. No matter how long it would be, mercury will fill all of it, because mercury here has no weight. But Bourdon barometers and manometers work properly, because in them elasticity of gases acts on tube or on box, whose elasticity appears also without weight.

— An ordinary pendulum (with lens) does not swing, and the timepiece does not work. Pushed pendulum (on thread) only revolves around the point of thrust, until resistance of air stops it. However, pocket timepiece and, in general, all machines and instruments, whose action is not based on gravity, work properly. For instance, the sewing machine...

— Heated air does not rise upwards, because there is no actual up. A lit candle or kerosene tubes become extinguished because there is no gravity; flame is surrounded by combustion products, into which oxygen penetrates only very slowly, by virtue of diffusion. How many instruments on Earth are based on burning in atmospheric oxygen! Here all of them will rapidly go out of order — for instance, any kind of furnace without artificial draft...

— Hydrogen and other light gases are not lifted and here aerostats do not rise; there is nowhere to rise to... Aeroplanes here are not needed, there is only needed motor for forward motion. Here the most dense body is located next to the lightest without support, — and they do not move anywhere unless they are pushed. Thus also in liquids bodies of any weight, form and volume remain in equilibrium. Archimedes' principle for floating ships and animals here is useless because it does not exist here, being based on weight.

— The siphon does not draw liquids. But air and suction water pumps work, — certainly, with surrounding elastic medium, as, for instance, in rocket. Pusher type water and centrifugal pumps act also in vacuum.

— Fountains, founded on gravity, here are impossible, but those founded on elasticity of air — work wonderfully: the stream obtained is straight and smooth, like a small glass stick. Only at a certain distance it bursts and will form a number of flying water bombs.

— Liquids, of course, do not flow from vessels, are not limited by horizontal planes, are not distributed in order of density.

— Partial or molecular forces of bodies appear in liquids with special clarity. Thus, each mass of liquid, no matter how great it is, takes the form of a sphere. You can smash it into several masses, and each will form a sphere. Water by itself enters into tube of any thickness and fills it all. Conversely, liquid, by molecular forces, is forced out of the tube, like mercury in glass tube, if its walls are not moist. Under the influence of solid bodies — grids, frames, and vessels — liquids take on extraordinarily interesting and infinitely varied forms. Thus, there can be obtained from water or oil forms of double convex and double concave glasses, which can replace the lenses of optical instruments. It is possible to make complicated telescopes and microscopes from wire frames and liquids.

— Varied fire motors will work during conditions of heating furnace with a draft. However, water in boilers will not separate from vapor, which may cause great disorder in such old types of motors...

— Isn't this enough physics? — stated modestly one elderly master, after which the Englishman hushed somewhat.

— True, — said Newton, — we will put aside the continuation of this conversation and experiments till another time.

— Gentlemen, — objected the young master, — let's have a break: let's drink some tea or coffee, we will rest and will listen anew. I want still to ascertain the action of cumbustion tubes in our rocket.

— Excellent, we are agreeable, — friendly voices were heard.

All settled sedately in their stands around a large vessel, which also was in a holder fastened to the rocket. From it there emerged twenty tubes. The vessel with tea and sugar added to it was heated in several minutes by electrical current. Then they let the liquid cool off somewhat. Someone pumped an exchange of air into the vessel. Each took the tube into the mouth and everyone drank the excellent tea with pleasure; each opened the crane as much as they wished.

Strength was raised; the tea was removed and they began to listen.

— You talked about the rocket, — said Newton. turning to the young master. — Well! On this subject I myself wanted to talk. Neither Segner's wheel nor water mill, nor water turbines could work here, since there is no gravity. But it is possible to show other reactive instruments, working on springs, steam, elasticity of gases, or other forces not dependent upon gravity.

— Here from this vessel a hidden spring throws off balls. Look, as gloriously moves the vessel in opposite direction... Here is another box. It ejects a stream of water by elasticity of compressed air in it. See, how fast, with all increasing speed, it flows in space of our hall... Here is another vessel or dirigible, call it as you will, — it moves wonderfully, throwing off a stream of steam on the stern end. See, how strongly it bumped against wall of the hall...

— Steam may be replaced by explosive matter as in a toy rocket, — noted Laplace.

— Yes, of course, — agreed Newton.

— That's all fine, — objected the young worker, — but all these instruments work so charmingly here, i.e., in a gaseous medium. The ejected bodies are repulsed from it, rest on it. If it weren't for atmosphere, there wouldn't be any motion.

— The motion of our rocket, in which we are now conversing, contradicts your conclusion, — said Newton. — After all our missile, with increasing speed passed hundred of versts into vacuum, pushed by pressure of expanding products of combustion...

— Yes, here we will now force these instruments, already shown, to move in vacuum, — stated Ivanov.

A very small vessel was launched again with compressed air before the spectator. It was attached to a column inserted in the hole of plate of an air pump, and drew the smallest circles, like a horse on a cord. It was covered by a large bell of pneumatic machine and air was hastily pumped out of it.

— Gentlemen! You see that motion, by measure of rarefaction of atmosphere of bell, not only has not ceased but is still accelerated. Under the bell there remained only the smallest amount of air, but motion of vessel did not stop, until the whole charge of condensed air emerged from it. Matter became evident from the factual side.

— Here, my friends, — noted Newton, — inertia plays main role, inherent with gases to the same degree as also in any matter.

— In what then is the basic principle of reactive instrument? — asked one of the audience.

— And here is what the matter is about, — said Newton. — Imagine in space free from gravity two balls and a spring compressed between them, resting in them. If we allow the spring to be expand, then to one ball it will impart a motion to the right and to the other — to the left. The same will occur if two rubber balls are pressed to one another and then released. Here even the spring is unnecessary... Or we will imagine a tube with compressed gas. If one end of it will be open, then gas will press only on the other end, and pipe, under the influence of this pressure, will be directed, we will presume, to the right. Then gas will be directed to the left. This instrument is the nearest of all to our rocket... The same will occur with a gun and cannon during firing.

— It is obvious, — noted a young machinist, — that in all these experiments the material medium surrounding the instruments, or atmosphere, plays a secondary role; perhaps even hinders the manifestation of reaction in all purity and force.

— Absolutely true, — noted Ivanov, — but the role of atmosphere still is not clarified with precision...

19. They Opened the Shutters

After dinner and a short rest again they met in the wardroom.

— Friends, — said Newton, — now we will open the shutters and we will see a wonderful spectacle... People with weak nerves should not for now participate in this celebration...

— Great celebration! — muttered someone who was hanging in the air.

— Later the braver ones will tell them of the experience, and thus they will prepare them for unusual impressions, — not paying any attention to objections, Newton continued. — Our reserves of light, different type of energy, food are very small. And, therefore, for the beginning we will limit at least the consumption of electrical power by using daylight...

They opened one of the double shutters and extinguished the lamp. Into the hall there penetrated a dazzling sheaf of solar beams. The other shutters were opened. The bolder ones approached the windows.

Exclamation were heard.

— The sky is absolutely black!...

— Soot was never that black!...

— What a great number of stars!

— How colorful!...

— I see absolutely the same constellations, but how many more stars!... And why are they so deathly still? There is no life in them, it seems as though they do not emit beams, do not blink; these are simply dots... How clearly they are visible! How close they seem, and how small is the celestial dome!

Mostly the group was struck by the blackness of the celestial dome and its apparent smallness.

Those standing by the windows saw the Earth left by them, at a distance of a thousand kilometers. At first they did not even understand what they saw. But then they realised that it was the Earth. This was obviously the central part, where between spots of clouds there loomed outline of lakes, islands, and continents known to all. It was something similar to a gigantic distorted map of the hemisphere. In the distributed maps of the hemisphere of the region they were more apparent and their scale twice larger than the central. Here conversely: the regions were quite abbreviated in the radial direction and were very vague.

— How strange is our Earth! It occupies almost half of the sky (120°) and seems not to be convex but concave like a bowl. People live as if inside this bowl.

— The edges of the Earth are very uneven and here and there are covered with huge pinnacles of mountainous summits. Further from the edges there is something foggy, still further there are a great number of elongated gray spots. These are clouds darkened by thick layers of atmosphere. The spots stretched along the circumference of the Earth and, with distance from the edges, brighten and become wider; toward the center they are round and any form, but are not stretched.

— The Earth, and also Sun, and stars seem very close; as though one could simply touch them with one's hand! All of them are as if located on internal surface of very small sphere.

— Sun seems very small, close, and dark-bluish. How small it is here and how hot. Stars are also mostly dark-bluish, but a great number are also colored.

Some of the men were stunned by the spectacle, fatigued, withdrew from their windows. Others did not even glance into them, being frightened by the exclamations. Many flew away into their cabins, closed the shutters and lighted the weak electrical lights. Others, to the contrary, passed impatiently from one window to another and did not cease to be surprised, to admire and to reason. Neither to give nor to take — like children getting in a railroad car or on steamer for the first time. The Earth attracted their attention most. It had at first a complete phase, i.e.,

was in full. But the rocket rushed rapidly eastward, and the phase decreased. The Earth took gradually the form of a huge concave Moon at a disadvantage. Its dark part was still visible, owing to weak illumination by the Moon. Boundary of dark and light part of the Earth was covered by huge pinnacles; these were shadows of mountains. The Moon was also visible and constituted also a part of celestial sphere, but only a tiny one, — and it, as also the Sun, seemed close and very small, much smaller than ordinarily. Actually, the angular dimensions of Moon, Sun, and stars did not change almost at all.

— Gentlemen, — said Newton, — our rocket makes a full turn around Earth in 100 minutes. A solar day continues 67 minutes, and night 33 minutes. In 40 - 50 minutes we will enter the shadow of the Earth. The Sun almost instantly will be concealed. We will barely be able to see the Earth, weakly illuminated by Moon, but the edges of the Earth will be brightly illuminated by colors of dawn. This light with success will replace for us the lunar illumination.

— I warn beforehand, so that nothing would happen to the ones with weak nerves...

Meanwhile the phase of Earth decreased all the time, and the boundary of shade and light gave all the greater slanting shadows of mountains and heights. It seemed that stars moved rapidly and drop to the Earth, as if descending on the pinnacles of the illuminated edges of Earth; they fall by tens, hundreds, and thousands: the Earth occupies such a huge part of the sky and so many of them are seen here in vacuum. On the other side of the Earth, where there appears slightly its dark part with huge shadowy pinnacles from approaching Sun, stars are as if born from nowhere. In fact, they come forward from the shaded part of the Earth and become visible. This stellar motion constitutes 3.6° per minute. This means that the diameter of Sun or Moon is passed by them in 8 - 9 seconds. Such is, approximately, all apparent motion of all celestial bodies relative to Earth, i.e., Sun, Moon, planets, and stars. How great are the visible seas and continents on it is clear from the following. Hundred kilometer distance, or one equatorial degree, during the most

favorable conditions is seen from the rocket at an angle of 6°, i.e., 12 times wider than the Moon. Thus, that's how in detail everything was visible on Earth which lay not too far from the central part, and not hidden too much by air and clouds. The spectacle was striking. Cities were excellently visible, large villages, rivers 100 meters and more in width. But sometimes nature dressed everything in one color, for instance in snow, and then it was difficult or quite impossible to note all this. What was seen in the telescope — to talk about this was terrible... Here, i.e., in the rocket, the atmosphere did not spoil the images, did not conceal small stars... Everything was entirely studded by stars... there was simply no empty place: the whole black sky was strewn with silver sand except the so-called coal sacks. They were black and empty here as always.

Everywhere are double, triple, multiple, and multicolored stars. Moment of black-out, or night, drew near.

— Gentlemen, — someone shouted, — edge of the Sun is darkened by the invisible rim of Earth...

In four seconds the Sun already was only half visible. Another four seconds and everything plunged into gloom; only in several minutes did the eye become accustomed and see the bright dawn around the dark Earth. The dawn was especially bright there where the Sun disappeared. This splendid dawn, about 10° in height, became more uniform: 16 minutes after sunset it glittered as an even, wonderful, crimson, huge ring, occupying somewhat less than half of sky (125° in diameter). The whole sky was divided by it almost in half. This red light was absolutely enough for reading, and there was no need to light a lamp. For certain people the spectacle was unbearable. Others only moaned and went from window to window. Since it was comparatively dark, one could see on the opposite half of the sky many more stars. They, like snow, continued to pour into this ocean of dawn; from the opposite side of the crimson ring they flow out with infinite sparks or fireworks. But the light of the ring weakened on one side, and from the other side was

inflamed, changing nuances. There hardly passed 17 minutes, as a line of the Sun looked out; everything sparkled, the dawn dimmed, and in nine seconds in its whole grandeur the full Sun looked out. Everyone almost turned blind from the light.

— Isn't the night great, — noted the young master, — and in only half an hour!

— This is an eclipse, and not the night, — objected his comrade.

— Night and eclipse together, — said Ivanov, — there won't be another night, and even if there were, then also a short one. After a day of an hour (67 minutes) — a half hour (33 minutes) darkness. Until we will change speed of our carriage, we are destined for a constant, although short duration of day and night...

— Have you noted the night is cold? — asked Newton.

— No, we somehow did not shiver, — answered voices from different directions.

— This is because, — said Newton, — first of all, our rocket is protected by a layer, poorly releasing heat from it; secondly, because the night is very short; finally, because huge, although dark surface of Earth irradiated our rocket and with heat. In general, also in our short night the temperature should decrease by a degree Celsius or even less.

— Thus, the short day and proximity to Earth have their benefits, — noted Franklin, — namely: we will not have cold nights.

— We absolutely do not have to pay attention to our night. Not to sleep half an hour! We do not have this habit. I proposed that we stay awake 16 hours and sleep 8, of course, that is approximately. Each one can create night for himself, closing the shutters, just as one can restore day with help of electricity. However, each can sleep and keep awake as he wants to. We are outside of any danger, and we do not need to have guards or to establish their relief...

Many days and nights passed, but in fact in all only 10 hours. During one of those short nights they flew above their native valleys of the Himalaya Mountains. There appeared familiar caps of snow summits. They could not discern the castle

even in the telescope. To Laplace there occurred the thought to telegraph by light (Morse code) to his friends remaining in the castle. The matter was simple: it was necessary to press a push button which gave a very strong current for an arc lamp of 100 thousand candle power. The light from this lamp was noticed and comprehended by those remaining in the castle. Pressing slower gave more prolonged light was acknowledged on Earth for a dash, and short — instantaneous light was acknowledged for a dot.

We resolved to sleep properly, like on Earth. Refreshed by sleep and weak coffee, our friends gathered in the wardroom.

— I beg you, gentlemen, to listen to me attentively, — Newton directed his remark to the meeting.

The speaking quieted down.

— Till now, — continued Newton, — we only observed, admired, were astonished, studied the conditions of our new life... learned, grasped, — but did not think about our daily bread. We do not have too many supplies needed for life. While they are still not exhausted, we have to resolve the question: for us to remain here up to their exhaustion and then to return to Earth, — which with our huge quantity of explosive materials can be made 100 times, — or to try prior to their exhaustion to find a method to produce vital supplies right here. Then our stay in the ether can be made a long one.

— Let's live still in the rocket and we will try to obtain bread. If we cannot manage, — we will return to Earth, — noted one of the audience.

— Yes, yes. Why not try, — exclamations were heard.

— Only will we obtain oxygen and food? — doubted a sceptic.

— If we do not, we will go home, — said a young mechanic.

— Well what, after all no one is risking anything...

— All right, we will live!...

20. Protests. Longing for Work. Artificial Gravity

There were found and protesting ones.

— Is it not best to return!...

— One feels somehow awkward...

— Something is lacking, — they said.

— Some sort of itch in the muscles, could be that we want to work!...

— This is easily accomplished, — noted Ivanov.

— We have many different kinds of foot machines, — exercise!

— It is to say, objected one of the workers, — I will place my leg on the pedal — and as a result will dash upwards: there is no gravity!

— That's true, — said Laplace, — but you did not note in machines certain attachments: for each leg on the floor there are belts with whose help one of the soles you attach to the floor; the waist is also fastened lightly with significant freedom of motions.

Thus, working for the common good, our protesting ones were fully satisfied.

But there were found other kind of dissatisfied ones: they longed for gravity.

— I want, — said one of them, — to see how water pours, how stones fall, to sit and lie down properly.

— And for that, — said Newton, — there is no need to return home. There is nothing easier than to create gravity here. For that to our rocket should be imparted rotation — better around the middle transverse diameter. Then in each chamber from centrifugal force there will be formed artificial gravity: in the end cabins, the greatest, in middle ones, i.e., in the wardroom, the least. Bodies will fall in them along the longitudinal axis of rocket, water will pour; everything

will be as on Earth: it is possible to sit, to lie, and walk, get tired, carry weight, and buckets full of water, and so forth.

— Here, for instance, — continued Laplace, — if the end of our rocket, which is one hundred meters in length, will pass one meter per second, then weight will be 0.002 of terrestrial, i.e., as on a planet with a diameter of 24 kilometers. The rocket here will make a full turn in 314 seconds (5 minutes). With 10 meters of speed per second the gravity will be increased 100 times and will constitute already 1/5 weight of Earth, i.e., will be somewhat more than on the Moon. Full turn of rocket will then be accomplished in half a minute. Such a speed of rotation will not cause dizziness.

— Said Newton, — rotation can be imparted to the rocket, by various methods. Should one, for instance, only revolve here this wheel or simply impart to it a rotary shock (it will itself continue rotation by inertia), the rocket will also start to turn. But this can be done more simply by means of two combustion tubes, turning their ends in opposite directions, perpendicular to the long axis of rocket...

All this was arranged, and the dissatisfied ones calmed down. Toiling until they sweated and admiring the gravity, they again wished to rest; then the rotation of rocket was stopped by detonation in a direction opposite to the former. For this there was expended an insignificant quantity the powerful explosive material discovered by Franklin.

21. The Rocket Turns into a Blooming Garden

— Well, gentlemen, you frolicked and were capricious enough, we will proceed to business while our supplies are still far from exhausted, — Newton proposed at the meeting.

— You see, — he continued, — on one side of the rocket, along side of it, there are a great number of windows. If one were to open all shutters, then we will have an area of glass 80 meters in length and 4 meters in width (one third of the circumference of the rocket). There is no need for a while of such an

abundance of solar beams. It would also turn out to be unbearable: it would become excessively hot and tiresomely bright for the eyes. This mass of light, with area of 320 square meters, which will constitute 16 square meters per man, can with the help of certain plants give us a great deal of oxygen and food products in the form of fruits, containing starch, sugar, oils, and nitrous and aromatic substances.

— Our reserve of food materials, even if it will not remain complete, at least will be expended several times slower, — added Ivanov...

Secretions from lungs, skin, kidneys, etc., were absorbed by individual vessels and were an excellent food for plants. Their seeds were planted in boxes with soil, fertilized by these secretions. When seeds started their sprouts, the vessels containing them were placed in a light area, the shutters were opened more and more. Unusual force of sunlight, not weakened by a thick layer of terrestrial atmosphere, its continuous action, the vertical beams, the absence of pests, most favorable conditions of humidity and atmosphere made miracles: a month had hardly passed by when little plants were entirely covered with juicy, nutritious, and aromatic fruits. Flowering was lavish, fertilization — artificial. There was no gravity, the twigs freely spread around, and their fruits did not burden and blend them. When the foliage became thick and almost covered the windows, only a layer of quartz could have remained, to remove glass plates from the windows. Then the development of plants under influence of abundance of ultraviolet beams went twice faster. But still there was not enough fruit to suffice for feeding, and even the stored oxygen was gradually expended for breathing. However, things were so good that it was decided to construct in time a greenhouse outside the rocket, in order to be fully satisfied and to be absolutely free from the need of reserves: to stand, so to say, on our own legs.

22. Pressure Suits Are Put on

While the seeds sprouted, while they grew, bloomed, gave fruits, while fruits ripened, — our friends did not lose time. They resolved to become a little better acquainted with surrounding space and to depart from the rocket, from their charming, blooming, aromatic corner: to glance on God's universe more extensively, not just through windows.

We will describe how it was. One of the bolder travellers once said while admiring the beautiful flowers:

— It's true that we have it good here, and the air is better and spacious: its corridor 100 meters in length — fly to and fro as much as you want!.. One hall is 20 meters in length and ceilings 4 - 5 meters in height — there is space where one can turn, fly and play... It is light, joyful, satisfying, and warm. Cheerful hopes do not leave us... Should it become worse then we can return to our excellent Earth. There it is, only thousand of kilometers from us!

— Everything is excellent, — he continued. — But won't we really ever depart beyond the limits of these walls, into this infinite, seemingly limited space which is seen from here through the windows?.

— Why not! This is fully possible, — said Newton. — For this purpose we even have attachments, prepared still on Earth, special clothes like pressure suits with instruments for breathing and absorption of products secreting from the body..

— Why not open a window or door and fly straight outside? — noted someone naively.

— Sun heats so gloriously, around are such charms, — how good it would be to stroll in free space!

— First of all, neither door nor window can be opened, — answered Laplace, — the air will immediately escape from the rocket, and we will instantly perish: on the body there should be produced pressure of atmosphere, and oxygen is necessary

for it. Secondly, if this even did not happen, direct beams of Sun will kill any mortal who is not protected from them by suitable transparent or opaque bodies.

— And how was it on Earth?.. The Sun did not kill us... — someone said.

— On Earth the beams of Sun are weakened twice by thick atmosphere and mainly, also are neutralised by it, although it is necessary to note, not quite: sunstroke is a thing quite common, — said Franklin, — especially in hot climate and in high mountains where layers of air above head are thinner and more transparent.

— At last, — said Newton, — even if we departed from the rocket, not releasing gas from it, which is fully possible, beyond its limits for a minimum of 800 kilometers (further begins the atmosphere of Earth) there is not a single gas molecule. What will we breathe and how to manage without accustomed and necessary pressure on the body? Although I pursue this question, it is only in order to show that it is impossible to flit directly outside through the open door of the rocket.

— But what shall we do? — exclaimed the one who had a thirst for free space.

— All questions raised by me already were solved by us on Earth, — said Newton — Pavlov, bring the robes necessary for life in vacuum, Do you know where they are?

— And how, and how... I will get them now and will return!

In several minutes he flew back with two pressure suits.

— I will explain their design, — said Ivanov, showing to the satellites the clothes and shells, which they examined with curiosity, approaching closer.

— In time, — said Ivanov, — it will be necessary still to descend to planets, into atmosphere unfit for breathing, — unfit either as a consequence of special composition, or due to excessive rarefication. In order to live in space, in rarefied or unfit gas, the same special clothes are needed. You see it. It covers the whole body, including the head, is impenetrable to gases and vapors, is flexible, is not massive, does not hamper motions of body; it is strong enough to sustain internal pressure of gases, surrounding body, and it is supplied in the head part

with individual plates, flat and partly transparent to light, for vision. It has a warm thick lining permeable to gases and vapors, contains reservoirs for storage of urine and so forth. It is connected to a special box, which emits oxygen continuously under the clothes in sufficient quantity. Carbon dioxide, water vapors, and other products excreted by the body are absorbed in other boxes. Gases and vapors constantly circulate under the clothes in the permeable underlining by means of individual automatic pumps. For a day there is needed no more than one kilogram of oxygen per man. All supplies will suffice for eight hours, and together with the clothing they have a mass not greater than 10 kilograms. But, however, nothing here has any weight. The pressure suit, as you can see, does not even disfigure a man.

— In the future greenhouses, where the gases are very rarefied, — noted Franklin, — we will also have use of these clothing.

— Even during work on the construction of the greenhouse they are necessary, — added Newton.

— Now, gentlemen, said Laplace, — will one of you wish to change into these clothes and step into space?..

All here flew away as though they were scalded; however, two remained. These were very young masters. They were the ones that were dressed up in pressure suits. With amusing motions, joking, and twisting, they rushed several times through hall showing evident contentment. Their voices were clearly audible even through the clothes.

23. Flight Out of the Rocket into Surrounding Ether Space

— Well, gentlemen, isn't it time to be on the way? — said Newton. — Only in such a form you will be steamed, — he turned to the "robed" ones. — Bring them white overalls, — he added. — This way... Put them on and attach them, so that they could not jump off... If you become co[illegible] . them, — he turned to the

excursionists, — then open them or roll them into folds, until there will be heat for satisfaction. You then will obtain desirable temperature. With full opening of overalls the average temperature of the black pressure suits can reach up to 27°.

But a higher temperature can be obtained, — noted Laplace. — For that it is necessary to prevent radiation from the part of the body not illuminated by Sun with the white overalls, and to open the illuminated one.

— Yes, but temperature higher than 20° is already burdensome, — objected Newton. — And there is likely to be more need to lower it rather than to increase it. And for that it is even necessary to cover up slightly against solar beams with a white raincoat.

— You, of course, know, — the Russian turned to the ones in the overalls, — that, departing from the rocket, you will dash into that direction from which you were repulsed during take-off. You will not be in a position to stop by yourself. You can travel about several years before again encountering the rocket. And during that time even much earlier you will die from hunger or even still much earlier you will suffocate from lack of oxygen.

— What! — exclaimed one of the ones in overalls, — will we choke in eight hours? This we did not foresee at all... Roam in the desert, in order to die?.. It is unfortunate that you did not warn us!

— I will not fly. — desperately exclaimed one.

— Me neither, — like an echo responded from the other through the pressure suit.

— Hurry, undress me!

— And me also...

— Well, here you are already cowardly, — said Newton. Listen to me. You are completely safe. At first, we will let you out on a leash...

— I humbly thank you... Like chained dogs!...

— You will fly on a leash one kilometer in length: you will fly where you

want to, and will return when you wished...

— And if the leash will break... — noted the older one in the overalls, with gloomy foreboding.

Doesn't mean a thing! We will give you a special little instrument in which you can evoke an explosion upon desire; it will act as a rocket and release gases in any quantity. With its help you can fly in any direction, which means also you can return when ever you want to your house.

— Only do not lose us from your sight, — counseled Franklin. — Or else you will roam, and will not find us. Therefore, in any case each one of you will take a telescope. I will attach one to your overalls...

— Well, what if suddenly, — said one of the dispatched ones, — I will squander away the whole explosive material... How will I then return to the rocket, even if I were only two steps away from it?

— There is a lot of explosive material here, but it also should be expended thriftily. One should not allow it to reach full loss — the counter shows how much of it remains. Furthermore, even if you were lost, we will detect you and will return you to your native penates.

— And if you will not detect us?

— And this is also possible, — said Ivanov.

— Then — we are through! — said one of the men in overalls and became sadly pensive, which was difficult, however, to see through the glass of the pressure suit. However, pride over took them. It was shameful to be exposed and made a joke of before comrades.

— We will fly. Trifles, — said one to the other. Their resoluteness inspired still several other volunteers.

— Now I also am not averse to flying, — said one of spectators, floating to and fro with impatience.

— And I!

— And I!

— Excellent, but later... In the meantime we will dispatch the ones already equipped, — said Laplace.

They were supplied with everything necessary and one of them they locked into a very crowded chamber like a case. For this, at first, the internal half of this cabinet was opened, then closed it hermetically and rapidly evacuated the remaining insignificant quantity of air from the case, — in order that not even a drop of it would vanish. The one in overalls expressed bewilderment and waited impatiently in darkness. In a minute or two the external half of case was opened, and the one in the overalls, being shoved, departed into space. In the same manner the other one was also released.

Everyones eyes were glued to the windows. One could see how the ones in overalls scattered into various directions and how the leashes were uncoiled, as they returned, flew again but in another direction, how their overalls were blown up, how they were covered by them, how they moved and revolved like children's tops (toy). All these motions, however, were already well known to the rocketmen: they for a long time already performed them in their closed location... Here, one of them became unhitched from the leash and flew far, so that he was hardly seen: but here his figure appeared again, began to grow, began to near to rocket, however flew somewhat past the rocket. A small smoke puff was seen. This was the one in overalls, activating the explosive machine; he changed his direction and flew to the rocket. Here he grabs the brackets, looks into the windows; through the glass one may see the laughing face. With signs he begs to come home... He is admitted just as he was released; not losing any gas, The other one appeared. He too is admitted. They are congratulated with their arrival. They are questioned from all over, it is noisy. They were unclothed, but the returning ones wanted to rest, they wanted to be alone...

— Wait. I will think over all experienced impressions, then I will tell all.

— Yes, let us rest, — stated the other returnee.

24. Story of the Ones in Overalls About Their Impressions

The sunset, came up again, and then after a two-hour rest our travellers appeared in the wardroom, to pass on their sensations during their stay outside the rocket. They were surrounded and awaited the narration impatiently.

— When the external door was opened, and I saw myself at the threshold of the rocket, I had a faint feeling and made a spasmodic motion which pushed me out of the rocket. It would seem that I already became accustomed to hang between walls of this cabin without support, but when I saw the abyss under me that nowhere around me there was any support, — I felt faint, and I rallied only when the whole chain already was uncoiled and I was one kilometer from the rocket; it appeared in the direction of the chain in the form of a thin small white stick. I was muffled in brilliant overalls which, reflecting the solar beams almost wholly, did not warm me. I became cold and apparently from the coolness I awaked. Quickly I pulled the chain and flew rapidly home. Gradually I calmed down, especially, when I saw myself near the rocket, when I saw the noses of the curious pressed to glass. Pride kept me from showing fear and from hiding hastily in the rocket. Floating for a certain time on the chain between the sky and the earth, I loosened myself and flew freely. When the rocket was hardly visible, I started into motion the explosive machine and flew back. Nevertheless, it was terrible... You saw, of course, how I turned like a top. But I absolutely did not notice this rotation: it seemed to me that the celestial dome with all its adornments and even with the rocket hastily revolved around me. But I could, nevertheless, stop this rotation due to two handles from mechanisms attached to the pressure suits. With these handles it is possible to give very fast rotation to two mutually perpendicular nonmassive disks; owing to it I could not only stop my rotation and give my own body any direction, but also get new rotation of any speed around the desired axis. It seemed to me, and no one could dissuade me in this, that I revolved by my own handles all celestial spheres

with Sun and stars, like a merry-go-round: at will I could turn this celestial sphere fast, at will slower, at will I could stop it. Axis of rotation of sphere also depended upon me. Rocket seemed to me the world turned as I wanted... Then I saw the Sun under my feet, and it would seem to me that any minute I would fall into its heated mass: my heart sank, but I did not fall. Then under the legs there was our huge Earth, filling half the sky; then it seemed to me that the bottom was there. Again the heart sank, and it seemed that any minute now you will dash to our Earth, will be smashed somewhere in the mountains or will sink in the ocean... I took the same position, — you saw from the windows, — as you also take here, i.e., it changed as we got tired of it or under the influence of conditions. If it was cold and I forgot to open the overalls for perception of hot solar beams then I curled up, as in bed in a predawn chill. If it was hot, the members of the body instinctively dialated, in order to increase the radiating and heat-emitting surface. If there was neither condition, then by measures of fatigue the pose changed: it was tiring to be in a stretched position, and while standing; I was compressed into a roll, assumed a sitting position, swimming position, spread my legs and hands, put them together, bent my head, lifted it, made all possible motions by the joints because the monotony was tiring... When I moved forward, you could see this clearly; I did not notice my motion and wouldn't have believed it for anything: to me everything (during strictly forward motion) appeared motionless, only the rocket here would approach me, then depart from me.

— Actually the rocket somewhat changed position, — noted Newton, — but since its mass is 5000 times more than the mass of a man, then it did not shift more than 20 centimeters.

— It seemed to me, — continued the narrator, — that I pulled the rocket by the chain, and it humbly obeyed... Only my rotation produced illusion of motion of sky.

— Yes, its a pity that in this ether space, in this wonderful world, full of

brightness and majestic beauty, one does experience the pleasure of motion... Maybe, this subjective sensation will pass, and we will be able sometime to sense our motion...

— There is almost nothing for me to tell, — stated the other one in overalls, — I experienced exactly the same things as my comrade, only I did not faint. I experienced fear but it almost immediately disappeared... Yes, my nerves are stronger!...

— You, gentlemen, of course, know, — he continued, — how huge and free is space surrounding the Earth, how it is full of light and how empty. This is a pity!.. How we are crowded on Earth and how we value each solar borough, in order to cultivate plants, to construct dwellings and to live in peace and quiet. When I roamed in vacuum surrounding the rocket, I was stunned by this great bulk, this freedom and ease of motions, this mass of fruitlessly vanishing solar energy. What hinders here people from building greenhouses and palaces and to live very happily...

25. Adjustment of Temperature of Rocket

— Pardon me, I will interrupt you, — apologized Newton. — You reminded me of one thing useful to us now. We will quickly finish with this. In what state did you find the surface of the rocket, which was earlier buffed? — he asked, turning to ones in overalls.

— Something looked white, somehow I did not pay any attention to this, — answered one of them.

— It appeared dull silver and shone like snow, — stated the other.

— I understand, this is the influence of high temperature of shell of rocket during its flight through atmosphere, — noted Ivanov.

— We, — said Newton, — till now heated the rocket somewhat and expended in vain the reserves of energy. We can stop this now. The surface of the rocket we will dress in places with a black toga. Thus, we will obtain the desired temperature.

At night it is possible to throw off this toga, in the daytime if it should be hot, — part of the folds could be gathered as you made with your overalls, — he turned to the narrators. — Now the whole group of us will depart from the rocket and we will study our business not only inside, but also outside of it.

— Parts of the rocket could be painted, — said Laplace. — Wouldn't this be faster? Only to regulate the temperature will be more difficult.

— During our first take-off we will settle this and will not expend any more stored energy for the supporting of sufficient temperature, — said Ivanov.

After the new conference it was resolved, that to obtain the average desired temperature, paint would be used. It could be easily washed off if it were necessary. Temperature of small chambers be regulated individually by internal means, i.e., with the help of movable screens inside or outside the cabins.

26. Conversation About Phenomena Experienced by the Ones in Overalls

The group separated for refreshment and rest and gathered only in eight hours. Time was measured in the terrestrial manner, in which there was no difficulty in view of Earth, Sun, and Moon and the full understanding by our scientists of the motion of luminaries and rocket. Ordinarily, there served simple pocket timepiece which were only sometimes checked astronomically.

— You, — Newton turned to the one in overalls, — in the past conversation brought up the question of possibility of living in free space surrounding us, about benefit of this life for people in comparison with life on Earth. The question is very interesting, we will talk regarding this subject...

— There is much that I still do not understand. — interrupted one of the listeners. — Will you not be as amiable as to solve preliminarily my questions in regard to the world surrounding us?

— Ask, do not be embarrassed...

— Why, for instance, you in overalls, leaping from the rocket, did not fall on Earth under the influence of force of its attraction?

— This is very simple. Leaping from the rocket, you have almost the same speed as it, i.e., you fly each second 7 1/2 kilometers; such speed is 10 times more than speed of a cannon shot, and it is sufficient to develop a centrifugal equal to the attraction of the Earth. You cannot fall on it. Take away from the Moon its speed, and it, like a stone, in five days will fall to the Earth, turning it in part into melted mass, in part into vaporous mass. Your own speed you also cannot lose, while you move in ether, whose resistance even if there is any, is absolutely not noticed, or, at least, doubtful. You rush like a fire-ball, which, until it encounters atmosphere or hits the Earth, will rush eternally by inertia...

This is all fully understood... but why does the sky seem black here? — asked one of those hanging in space.

— Have you ever gone up a mountain? — asked Laplace. — Have you noticed how the sky darkens as you get higher? At altitude of 10 kilometers the aeronaut sees the sky dark — very dark. Blue or dark blue color belongs to air. Remove it, — and all the blue will disappear. Here air is lacking, whence from should the blueness come?

— And air in the rocket... — noted the conversationalist.

— Its layer is so thin that it cannot inflict any noticeable coloring. Similar to this, a thin film of water or glass is transparent, and the thick film is colored.

— And is this clear... And why so many stars, why don't they blink and why are they so brightly and variedly colored?

— And here also the cause is the absence of thick layer of terrestrial atmosphere. Beams in it flow extremely incorrect, thanks to its heterogeneity, besides constantly changing: either they are dispersed and the star weakens and disappears, or they are gathered and give a bright image to the eye, or they deviate to one

side and the star seems as though fluctuating. Here this is impossible, and luminary is projected to the eye as a bright point... Now further: powerful layer of terrestrial air absorbs and disperses most of all beams of high refractivity — violet, dark blue, blue, most of all it emits red beams, which are noticed in predominant quantity by the Earth's observer (in zenith stars this is less noticeable). And here, the stars from the Earth seem reddish, even if their true predominant colour in vacuum is blue, green, or any other. Thus, through a red glass all clouds seem red. Here, in ether, of course, we see stars in their natural color, not distorted by a huge, more than two hundred kilometer layer of air. And since they are by nature multicoloured, then we also see them here as such.

— The atmosphere, — said Ivanov, — not only disperses light of stars, absorbs it and completely muffles weak stars, but also hinders their visibility due to its own light. By day the colour of atmosphere is so strong that it conceals from us completely the stellar sky; at night this scattered, borrowed light only weakens the colour of stars, though the small ones are completely concealed... This is why we see here such a great number of stars!

— Why does man not notice his movement in ether? — the voice of one of the masters was heard.

— Because in it there are no criteria of movement or that which accompanies movement of man on Earth. Namely: the resistance of air is not felt, there is no shaking, no shocks, no oscillations, there is no reflux of fields, gardens, houses, etc. We have come to somewhat believe the inside of our little rocket, but the external we still do not believe; this can pass, and then we will realize our own movement not only in rocket, but also in ether. How many thousands of years have people not felt the rotary and forward movement of Earth and solar system? And now — we know about it, but do not feel it, in spite of all efforts of will.

27. Discussions on Life in Ether

— I do not hear any more questions, — said Newton. — We will talk about advantages of life in vacuum and without gravity.

— In my opinion the best is the fact that no efforts and expenditures for proper motion and shift of any kind, even the most huge, masses are necessary; tension of muscles of people and animals is not necessary... — said one of them.

— Trains, steamers, horses, dirigibles, airplanes, carbon, wood, and so forth are not necessary, — drawled another.

— Speed of movement may be exceptionally great; there will be demanded only a simultaneous insignificant expenditure, i.e., the first shock. Movement does not disappear, because there are no obstacles in the form of friction of air, water, — stated a third.

— Consequently, relation of people, shifting of masses for any distances and with all kind of speeds doesn't amount to anything...

— The benefit of buildings and of any constructions which will not be destroyed because of gravity are huge. Their walls can be very thin, construction huge without limit, gravity will not destroy them.

— How pleasant it is to feel that you cannot fall, be smashed, that you will not collapse into a precipice, that the ceiling will not fall on you, that the wall will not squash you... that you will not drop, will not break dishes... It is possible to work in any position.

— Yes, this is not bad, but more important is the mass of light, solar energy, free space..

— Where are the clouds, mud, dampness, fog, cold, heat, exhausting labor?.. — pronounced enthusiastic voices.

— Where is the darkness and the cold of night, where is the icy wind, snow,

and snowstorm, where are the cyclones, shipwrecks, impassable deserts, inaccessible mountains?!

— Gentlemen! You are carried away! — said Newton. — Certainly, all this is so, but here also like in a rose we see thorns; we should not forget about them.

— What thorns? — everyone around became noisy.

— Should I open a window or to pierce this wall, to even break accidentally a glass, and all of us will perish, because we will find ourselves without air, which instantly will flit from the chamber in virtue of its infinite ability to be expended.

Many looked back with terror.

— We have double glass, thick, strong, with mesh fused inside; but nevertheless it is possible to smash them carelessly... The walls are metallic, but it is possible to crush them...

— We will close our eyes on this dark side of our new existence and will turn to its brighter sides, — said Laplace.

— Temperature here can oscillate from zero to 100° C and more, — said Ivanov, — should one increase the area of rocket with dark color. From this the temperature will be increased, as far as we wish, for instance, up to 25°. What would we need our clothes then... Our clothes, indeed, we cannot wear out; soles do not wear out, however, there will be movement, there will be work on machines... we cannot keep our limbs totally motionless... All this, finally, destroys clothes.

Thus, the meeting resolved promptly to significantly lighten their clothes and simultaneously to bring the temperature of the rocket up to 30°.

— A very low temperature, — said Franklin, — cannot be obtained here, owing to the proximity of Earth, which by its surface, whether ill inated by Sun or not, continuously radiates and heats the rocket. However, a high degree of heat, up to 150°, is easily obtained: — by simple color and protection from losses of heat, and higher — with the help of spherical, more correctly — with parabolic and flat mirrors.

— This makes it possible to actuate various kinds of solar motors, to weld metals and to produce a great number of factory operations without fuel.

— Temperature is focus of similar spherical mirrors, — said Newton, — at constant angle of apertive (my calculations are based upon works of Stephan) does not depend upon magnitude of mirror. Its magnitude only proportionately increases the hearth, i.e., the surface of heating. This temperature at angle of 60°, or with the arc of mirror at sixth fraction of circumference, with black surface of heating and ideal reflection of light by mirror, should attain in vacuum 4402° C. It even does not depend upon the proximity of the mirror to the Sun; the diameter of the hearth grows proportionately to the angular diameter of Sun, i.e., with approach to Sun the hearth is increased; with withdrawal — decreased. Mirror with an aperture of 120° brings the temperature in focus up to 5000 - 6000°. On Earth half of the beams are absorbed atmosphere; subsequently, conical beam is strongly cooled by air. Thus, under the bell of air pump with ideal transparency of glass not more than 3000° would be obtained. Under ordinary conditions, of course, this temperature will not be obtained. However, even platinum is melted in focus of mirrors. (Consequently, even on Earth the temperature in this case is higher than 2000°. Magnitude of hearth or diameter of focus, i.e., solar image, for mirror with radius of 1 meter (with 60° aperture this will be the diameter of mirror) constitutes 4 millimeters. With diameter of mirror of 10 meters also the hearth will be 10 times more, i.e., 4 centimeters. In vacuum here, we, surely, will obtain temperature up to 5000 - 6000°. By special methods it is possible to raise it yet more, but there is no need for this.

— This means, — noted Ivanov, — here it is possible lavishly to produce all possible metallurgical works! — naturally, outside the rocket, in ether vacuum, wearing pressure suits. This is not the same as in air: oxidation of metals and instruments spoils any work. Here, for instance, welding is easier than easy: focus is directed on weld parts and they are alloyed by a small stick of the same

metal; contact of incandescent parts is even sufficient. Aiming of focus is exact, adjustment of temperature is still more exact... This miracle is wonderful!..

— One should not forget, — added Ivanov, — that mirrors here do not blend from gravity, their shifting and rotation in light machines is not difficult, their surface does not oxidize and does not dim... Simply wonderful! Preparation of mirrors even with diameter of 1000 meters is fully possible, and such a mirror, gives hearth with a diameter of 4 meters... What? But also a small mirror, with a small hearth permits subsequently to weld large surfaces.

— Here you again with your absence of gravity... Certainly, it is unquestionable, since I do not feel it, but to me all this is somehow incomprehensible: the Earth is so close, its gravitation is almost unchanged... Why don't we feel it? — asked an elderly master.

— I already explained this, —said Newton. — But here let us consider another point of view: do the inhabitants of Earth feel the attraction of Sun and Moon? It is there, but, of course, no one feels it: it isn't taken into account even by scientists. It shows only in oceanic tides. Attraction on each planet and its moons depends only upon their own masses. Even the most fastidious astronomers do not take into consideration the influence of the mightiest suns. And in our rocket the attraction depends only upon the mass of the rocket, its form, etc. And since its mass is insignificant in comparison with mass of any planet, then its attraction is also unnoticed.

— And, nevertheless, also absence of gravity, — said another elderly master,— is not quite all right, sometimes this is actual sadness. For instance, in the rocket a lot of miscellaneous trifles fly about, dust does not settle — how can one remove it?.. Water splashes and cannot be kept in open vessels... it is inconvenient to take a bath, to wash... in general, it is awkward in the toilet...

28. Bath

— First of all, you did not notice, — said Laplace, — that air in the rocket is constantly strained through special filters and is cleansed of all impurities; perhaps a pencil flies off without being noticed, but this is from our carelessness. Secondly, you, probably, have not had yet an opportunity or time to take a bath in the special bath for that.

— Yes, I haven't had yet the opportunity to wash up, — said the good-natured, stout person.

— Our bath, — noted one of the young workers — consists of a cylindrical tank 3 meters in diameter. It is closed with the exception of one hole, and can rotate around its axis. Water occupies half of its volume. Those taking a bath give the tank a light rotation causing the water to gather along the cylindrical walls and to be limited by the cylindrical surface to a single depth. From centrifugal force those bathing disposed along the curve of surface and are submerged up to the chest in water. Their heads are turned one to the other, like spokes of a wheel. Wonderful washing... several windows... various attachments.

— The devil! And I did not even know... I want to bathe...

— This is always possible, — noted the narrator.

— Then, — continued Laplace, — no one hinders us to obtain gravity in the whole rocket by its rotation, which we already have done. This gravity is retained as long as we want this, and with no difficulty. It may be obtained also outside of the rocket, in any construction. Light rotation of a vessel of liquid or rotation with a paddle forces the liquid to gather along equator of vessel and to remain there. Turn this pot and you will see that the liquid will not emerge from it. It is simpler to close it tightly with a cover and to revolve the liquid with paddles only then when it is necessary to obtain liquid from the vessel. Then open the cock and it will pour freely.

— We take a bath very frequently, — said one young man, — I so love bathing! — he added. — Why is the water always clean? Or is it frequently changed? But we could not have infinite reserves of it?!

— It is cleaned very frequently — by means of distillation, filtering, and chemical and various physical methods; also it is rendered harmless by heating and other means, — noted Ivanov.

29. Summary on Life in Ether

— We will summarize our conversation, — Newton said after a certain pause. — Owing to the Sun we have here desirable temperature and, therefore, can manage without clothes and footwear; the absence of gravity also promotes this. The same absence of gravity gives us the most delicate feather beds, pillows, seats, beds, etc. To it we are obliged for free and fast moves to all possible distances; feeding and breathing will be absolutely ensured, if we will create several greenhouses. Even available surface of rocket would be sufficient for us, if the productivity of the considered plants were perfect. The space, which may be occupied by us around the Earth, if one were to consider only up to half of lunar distance, obtains a thousand times more solar energy than the globe. This space or ring, — which will be occupied in time by our followers; I mentally presume it to be perpendicular to solar beams. It is even now already ours, one need now only fill it with dwellings, greenhouses, and people. Thanks to parabolic mirrors we can obtain temperature up to 5000°; the absence of gravity makes it possible to construct mirrors of almost unlimited dimensions and, consequently, to obtain hearths of any area. The high temperature and chemical and thermal energy of beams of Sun, not weakened by the atmosphere, allow to produce all possible factory operations — for instance, welding of metals, singling out of metals from ores, forging, casting, rolling, etc... It is true, here there is no terrestrial variety, no poetry of mountains, oceans, storms, rains, cold; but on the one hand, we are not quite deprived of it, —

said Newton, indicating the visible outline of seas and mainlands of Earth. — On the other hand, this poetry brings to the majority of mortals on our planet only unnecessary and even frequently unbearable and painful troubles... Earth nevertheless remains ours; it is always ready to embrace those who cannot stand to be separated from it. In other words, it is always possible to return there. And isn't there any poetry here? Don't we have science, substance, worlds, humanity, which will surround us occupying this infinite space?! Isn't man himself the highest of poetry!.. Isn't the universe from here more ours than from Earth?

— Well, alright, — interrupted Ivanov, — now allow me to enumerate the adversities of this world. Proximity of Earth does not permit us to obtain low temperatures by easy methods, and it is very much needed for best work of solar motors, for factory purposes; for instance, for liquefaction, solidification and convenient storage of gases.

— This hindrance can easily be removed, — said Newton, — one need only depart from Earth... We even can obtain much more space and sunlight, if we will form a ring of our new dwellings around the Sun, located beyond the orbit of the Earth. There we will obtain a million times more energy than the Earth obtains now. Temperature there can easily be brought almost to absolute zero...

— You are right, deficiency of low temperature will be removed, — conceded Ivanov. — But then I can indicate to other dark sides of our stay here. Clothes, furniture indeed are not necessary, but, after all, we are confined in a prison, even though it is light and excellent!... We can move beyond its limits only in pressure suits — very complicated devices, far more complicated than clothing...

— Pressure suit — noted Franklin, — serves for one and the same purpose, to surmount the same obstacles. Here it is needed for every one. Production of the same thing in billions of copies will attain perfection and cheapness, — and hardly will the pressure suit in this respect be considered with clothes. But the dwellings here also replace clothes. Arrangement of dwellings here is strikingly

simple and monotonous. Thus, one can say: if there are dwellings, then clothes are not needed...

— This is so, but we in these dwellings are subjected continually to danger of losing gas and to perishing! — said the Russian.

— Dwellings will be as monotonous as also clothes; they will be constructed for billions of people. They also will attain perfection. Besides, the conditions surrounding them here are extremely monotonous, which is why their perfection is also as easily attained as perfection of pressure suits. And isn't each man even now continually risking his life? Puncture your heart, damage a vital joint, wound carotid, cut open an aorta, — and you will die. Besides the surrounding population will be so numerous, so wise and solid, it will have such means, such weapons that it will always be able to remove any danger and misfortune... I cannot draft here in a thousand years all the possibilities of improvements, or foresee all that is ahead, — added Newton with emphasis.

— Maybe, humanity will even be so converted, — noted Franklin, — that in vacuum it will not have need for pressure suits or in dwellings.

— And maybe still earlier, — added the Russian, — it will create in an ether unenclosed gaseous atmosphere, which it will use.

— Oh, all the thoughts cannot be transmitted! — said Laplace.

30. Picture of Bathing

— Gentlemen, enough!.. Let's refresh ourselves by bathing, — exclaimed one of the listeners.

The proposal was approved by many, and they pushed off, flying into one of the sections of rocket where the bath was located. They saw a great drum which occupied almost all of that section of the rocket, namely almost 4 meters in length and 3 meters in diameter. At first, it was brought into slow rotation. There was no gravity, and the drum revolved by inertia: a little bit of work was necessary

to maintain this rotation. Then in the center, by the axis, a hole meter in size was opened. Removing the elegant belts and colored girdings — the attire is very light, not burdening, — they flew one after another into the bath. On the walls of the drum there stood water in the form of a cylinder, revolving with the drum. Pushing off from each other, they flew into the water, which imparted to them motion and made them have weight. With what pleasure they plunged into the cool liquid! How easy it was to bathe here. Above his head Ivanov saw Newton, who was bathing and playing in the water in the same gay manner as he was; next parallel, Franklin was disposed; the bodies of some of them were disposed perpendicularly one to the other. In order to see Newton, he had to lift his head, as though examining the dome in a church. All were turned one to one another with their heads, feet, and legs separated. Only in this was the bathhouse peculiar; in other respects it did not differ from a terrestrial one. They ducked their heads under water, dove, grabbed one another by the feet, splashed, swam lengthwise and agitated the water around, screeched, laughed and, in the main, were excellently refreshed. They did not create here great gravity. What for? Thus it was easier to swim than on Earth... Here revived all the perished hydrostatic and hydrodynamic laws based on gravity — for instance, Archimedes principle. Having played, romped around in the same method the company flitted from their bath just as they had flown into it. It was not necessary to dry off: beams of Sun, always shining through the thick green plants, dried them rapidly. They put on the loin cloths and went about their business. The water was filtered. Deposits in the filters went for fertilizer.

31. Greenhouse

New meeting was opened by a speech from Newton about the situation.

— Here, gentlemen, — he started, — I draw your attention to our worldly affairs... Reserves become less and less. They are turned into fertilizer for plants, but fruits and vegetables are insufficiently developed to use all the

fertilisers. The dimensions of the rocket are rather small for that. It is necessary to attach to it, to the rocket, a greenhouse. Then there will be still more space for strolling without pressure suits. Then it will not be necessary to expend more reserves of oxygen and food: surplus of plants will give us both. All our excretions and waste materials also will wholly be absorbed. We will take from the plants as much as we give to them. To save reserves will also not be needed: we will part with them and will be satisfied by carbon and nitrous substances of fruits. With our easy life, the absence of heavy labor, thirty-degree temperature this will even be useful and necessary.

— Wouldn't it be better to organize these greenhouses separately from the rocket? — noted Laplace. — Plants do not require such mass of gases, such pressure of medium, as do humans. Atmosphere for plants is also individual, special, with surplus of carbon dioxide, humidity, etc. All this does not correspond to people. Dimensions of greenhouses can be limited to a tube two meters in diameter, so long as the horticulturist can fly freely, in order to gather fruits and to take care of them. This is the small density of surrounding their gaseous medium which will give the possibility of considerably economizing on building materials, our reserves of which are not without limit.

— Certainly, that is so, — agreed Newton. — We have, it seems, parts of the greenhouses almost ready and are adjusted namely to such a view on things. There is sufficient free space also in the rocket, but small — no one hinders us from strolling in pressure suits for hundreds of versts around. And the actual rocket owing to combustion tubes and huge reserves of explosives can depart from Earth and travel, wherever it wants: on the Moon — then to the Moon, to asteroids — then to asteroids... And now it travels and shows us pictures of Earth one more beautiful than the other... Thus, even without that we continuously travel... We will join the greenhouse to our rocket by two thin tubes: one will remove from the rocket to the greenhouse accumulated carbon dioxide and other human excretions, and

the other will deliver to the rocket fresh oxygen and ozone developed by the plants. It is impossible to manage here without pumps; but here solar motors, still stored on the Earth, work excellently.

— Care of plants, — said Franklin, — is amazingly easy here. The soil is burnt and freed of weeds, harmful bacteria, and parasites. Useful bacteria, for instance, leguminous, we plant ourselves. This means it is not necessary to weed or to pull out unfit grasses. But it is necessary to watch for suitable composition of soil, moisture, and atmosphere.

Composition of liquid or soil for plants is made up before the actual planting the soil is moistened by pumps automatically. They draw in and send the water, which gathers by condensation vapor in certain, coldest parts of the rocket. Fertilization of flowers is accomplished almost instantly by blowers. The atmosphere is formed by human respiration. At last, fruits without any pestilence freely spread in all directions, not burdening the stems, since there is no gravity.

— And will it not be necessary for us to go outside for these separate constructions? — asked one of the masters.

— Absolutely, — said Newton. You don't like this?

— On the contrary, I want very much to stroll outside the rocket, — I still have not been out there, — objected the same voice.

— We will be there for work, — said Ivanov, — It will be necessary also for gathering of fruit and their care by frequently to visit the new greenhouse in pressure suits, since the pressure of the gas in it will not be sufficient and the atmosphere will not be adjusted for breathing of man.

32. Construction of the Greenhouse. Inexhaustible Vital Products

In several hours the construction of the greenhouse started. The spare parts, consisting mainly of cylindrical thin plates of special, strong and elastic glass with square mesh wire fused inside it, were unpacked. There were spherical parts, there were already prepared metallic attachments and very thin pure metal sheets.

All materials gradually were pushed into special chamber, the air was pumped out of it, and then the hatch outside was opened and they were ejected into ether space. Big items were simply attached to the rocket, smaller ones were placed in a special spherical wire cage, which had been beforehand moved outside the rocket beforehand. There these materials scurried like beasts from corner to corner and for a long time could not settle down. Cage, of course, was attached to the rocket and had an aperture which could be closed. In several hours the previously numbered elements were adjusted one to the other by ten masters who emerged from the rocket as was described. At first, they were as if torpid, made awkward motions, but quickly rallied and started their business, comically-cautiously looking to the sides and under their feet, where there was the abyss. Work was very easy: no matter how massive the part was, for its movement not the slightest effort was required; barely [lightly] joined items did not separate, did not drop, did not deviate, and did not bend from gravity, no matter how huge, thin, and weak they were. The foreman gave orders. Strained elastic threads between their pressure suits permitted them to talk freely in an ordinary manner with each other — even all simultaneously, although from this as always, there was confusion. Vibratory motion started in the pharynx, was transmitted by air of the helmet to the pressure suit, then to the threads, and finally, through the thread (in spite of surrounding vacuum) to the other pressure suit.

Shell of the greenhouse, was apparently ready, but its parts were still not welded and could freely pass gases in the joints.

They began welding, i.e., hermetic sealing of transparent and opaque sheets. And this was extremely easy. The workers, without effort, surrounded the greenhouse from all sides and found all their positions equally convenient: with respect to their construction they were also parallel, and perpendicular, and slanted; they stuck to it like flies. But welding required a definite position of the greenhouse in relation to the Sun, since welding was produced in focus of parabolic mirrors.

The work reminded one of autogenous welding on Earth, but it went easily and unimpeachably, since there was no oxygen, combustion, no inconvenient, unnatural poses; the temperature was higher and constant. In a word, it was fun, rather than work. Only frequent setting of the Sun, 67 minutes after its ascent, distracted from the business. But also after sunset it was absolutely light and warm: the Earth, occupying a third of the sky (120°) illuminated and warmed them. Therefore, it was possible to continue at night the work not requiring solar heat. However, change of labor was unpleasant: one did not feel like stopping work that went so well. But half an hour passed (33 minutes), and the Sun again in its whole splendor emerged almost suddenly to the rescue...

Quickly the welding was completed, its impenetrability tested, the apparent cracks and holes welded; they worked some more and, finally, were convinced of the full impenetrability of the greenhouse to vapors and gases. There was obtained cylindrical tubes 500 meters in length, with a diameter of two meters. Over the full length of it there was a huge window, occupying in transverse direction a third of the circumference of the pipe. If one were to imagine it horizontally, then the width of the window would constitute 500 meters, and height about two meters. In spite of the dimensions, this pipe was not very massive; it was strong, flexible and indestructible. Even if it were possible with hard work to smash the glass, then this still would not be accompanied by leakage of gas, since the fused, durable metallic grid did not allow the glass to disintegrate into pieces; the hardly noticeable cracks almost could not release gas. Blows only bent and elastically vibrated the wall. Near the ready shell in their pressure suits the masters rushed around, threw things to and fro, collided which caused them sometimes to turn amusingly; but they firmly braked their rotation and admired their creation from all directions and at various distances.

There remained to place in the greenhouse a vessel with semiliquid soil, to admit rarefied gases, plant seeds, to adjust temperature and humidity regulators, fertilizers and the composition of the gaseous medium.

Along the full length of the greenhouse there was placed along the axis a long sectional opaque metallic vessel. It was filled with semiliquid soil and had a great number of holes, where seeds or seedlings were put. Inside of it the walls were moistened by liquid, but not on the outside, since it was enameled with a special mixture on the outside. Due to this the liquid could not penetrate outside, but in virtue of known laws of wetting it remained inside the central pipe. Inside the main pipe there were placed, almost in its center, two thin tubes also with along the whole length. One of them delivered gases to the soil, the other — liquid fertilizer. Air pumps, working constantly, gave mixture of gases, penetrating all of the soil. Other pumps delivered liquid with fertilizing substances, also penetrating into the soil...

You, perhaps, were amazed that from a rocket there could emerge such a huge piece as a greenhouse, but, first of all, its volume is almost the same as the rocket's, secondly, pressure of gases and vapors in the greenhouse is so insignificant that its walls could be very thin, in no way thicker than ordinary cheap glass. Because of this the whole shell weighed about 20 tons, while the weight of the rocket with all contents constituted 400 tons. This greenhouse had 1000 square meters of surface, illuminated, during two thirds of the local day by normal solar beams; for earth man there were 50 square meters!.. It is not difficult to imagine what a huge quantity of the most nutritious fruits provide this surface could give, with the wonderful conditions of growth and illumination! The glass was from pure quartz and, therefore, excellently passed chemical beams which promoted harvest.

Finally, everything was arranged, sown, the greenhouse function correctly. There appeared sprouts. One part of the greenhouse is transparent — it is always turned perpendicularly to the solar rays. The rear surface was twice larger, but, reflecting excellently the scattered sunlight, illuminated the darkened part of the central pipe with the first appearing, delicate small leaves. Nevertheless, the distribution of light was nonuniform. Therefore, the soil pipe was turned in such a manner that the young plants received solar energy completely even. The turning

was automatic, but its also possible to do it manually without emerging from the rocket. In general the adjustment of fertilizer, light, etc., could be produced from the rocket: one can't put on the pressure suit everytime! It is necessary to note that both the rocket, and also the new greenhouse were always located in the most advantageous manner relative to the solar rays. Certainly, this could have possibly been attained by vigilant observation; but here the matter was much simpler. It is known that the rays produce on bodies small — better to say, extraordinarily small — pressure. Actually, it constitutes only half a milligram per square meter of surface. No matter how small it is, it is this which served as the regulator of direction of the greenhouse. By itself this force is too small to turn the rocket, but it served like a compass on a ship. However, there were still simpler methods to attain the same goal; any convexo-convex glass in the wall of the greenhouse gave in its focus light and a hot spot on the screen. Its deflection from the fixed point actuated, by various methods, regulators of direction of the greenhouse and returned it to its former position... It was still easier to attain a definite position of rocket and greenhouse by their light rotation around either axis.

Garden strawberries, wild strawberries, various vegetables, and fruits grew not in days, but in hours. Great number of fruits had crops every ten or fifteen days. Dwarf apple trees, pears, and other small fruit shrubs and trees were planted. These bloomed without interruption and gave amazingly large and tasty fruits. Some of the trees blossomed, others had already ripe berries. Especially fruitful were watermelons, melons, pineapples, cherries, and plums. But one had to constantly prune back the growing shrubs and small trees. Fruits of any sort were gathered continuously at any time since there were no seasons: there was a continuous, constant climate. Only artificially it was possible to change it — and even within very wide limits. This is why it was possible to raise plants of all countries. Large trees now were impossible because of the small dimensions of the greenhouses, and

the lack of sufficient soil and fertilizer. When these desert ethereal spaces are settled by millions of living intelligent creatures, then the matter will be different...

The greenhouse was frequently visited for the sake of collection of fruits and for the sake of a walk. Without pressure suits this was impossible to do, since the pressure of gases and vapor in the greenhouse did not exceed 20 millimeters of mercury, i.e., it was 40 times less than the pressure of the atmosphere and was insufficient for man. The mixture of gases, excellent for plants, was quite unsuitable for people. Water vapor by far did not attain degree of saturation respective to the temperature, because before saturation evaporation of leaves and soil was condensed in special adjuncts of greenhouse, which were constantly in shade and therefore, had a temperature close to zero. Thus, the vapor pressure was not more than 4 - 10 millimeters. Carbon dioxide, oxygen, nitrogen, and other gases also were in a very rarefied state. But this, as it is known, has little effect on the productivity of plants.

Thus, the content of main gas for plants — carbon dioxide — does not exceed one thousandth on Earth, i.e., the partial pressure will be not more than one millimeter.

Visit to the greenhouse, especially at first, gave great pleasure. Plants of such mass filled all the space that it was hardly possible to fly among these wonderful greens and fruits. With motion the bodies were disposed along the pipe, in order not to be entangled in the fruits. But nevertheless one became entangled, and mature fruits bounded from the stalks in huge numbers. Actually they did not drop as they ripened, they did not have weight. But also the fruits breed from the stems did not drop anywhere, flew to and fro, lengthwise and across, until they got stuck in the thick foliage. Flying like birds, our idlers could have been filled by simply opening their mouths, but, unfortunately, the pressure suits hindered this. Fruits and berries only bumped against the glass of helmets and then rebounded; one had to catch them with nets like butterflies, and lock them up in light semitransparent bags.

Entrance into the greenhouse was not simple in spite of the pressure suits. It was necessary at first to fly from ether into chamber at the greenhouse like an anteroom where there were no gases, then the door to the outside, in ether, was locked, and air from greenhouse was admitted into chamber through an internal open valve; through the humans passed in the hothouse.

When greenhouse and rocket were connected by the same passage chamber, the matter was simplified. A man dressed in a pressure suit first entered a connecting chamber with gas of the rocket, then this gas was pumped into its habitable part, the next door was opened, and the man entered the greenhouse. If he then wanted to depart from greenhouse into ethereal space, then he passed into ether greenhouse chamber with two doors; from it there passed completely gases and vapors into greenhouse; finally, the door into ethereal space was opened, and one departed into freedom.

33. Sorrowless Life. Telegraphing by Sunlight

Now our acquaintances settled down solidly enough. Reserves were eaten, but there was no need for them: in the greenhouse there continuously developed wonderfully delicate, aromatic, sugary, butyrous fruits, and vegetables. The more of them consumed, the more bigger fertilizer was obtained and the bigger the nutrients grew, — of course, up to the limit, set by the solar energy falling on a surface of definite size. Living organisms here expended so little energy on movement or on the struggle with low temperatures that even the vegetarian diet caused them to become fat. Eternally resting in the "feather beds" of a medium free from gravity, they were insured also from any disease. Where could illnesses and contagious beginnings come from? Even if bacteria started, the piercing rays of the Sun destroyed them without mercy. Only they could not produce full disinfection inside the human body.

Absolutely ensured in their economy, they could continue their blissful state to the very death — if death has power here...

Almost every day they washed up or bathed. The bathroom easily was turned into a fountain. Then it was pierced in all directions with infinite artificial rains, producible by centrifugal pumps actuated by solar motors.

One became peaceful; with it came boredom. One looked for new activity. It was necessary to send detailed dispatches to the Earth about its state, works, successes, and happiness. Main electrical reserves were already expended, and telegrams had to be sent by another method.

Calculations of the Russian participant of the expedition showed that sunlight reflected by flat mirror is 40 thousand times more intense than when scattered by a dull surface under the same conditions. There is as much sunlight here as could be, and also mirrors. Such a mirror of one square meter reflected as much light, as a dull silver surface in the form of a square with sides of 200 meters; from Earth, at a distance of a thousand kilometers, it should be visible as a brilliant planet with diameter of 0.7 min. It is clear that it will be visible to the naked eye. Indeed, the diameter of the most brilliant planet — Venus — in period of highest brightness attains only 0.6 min. And even then not the whole circle acts, but only a narrow sickle. It is clear that even this mirror can be seen incomparably better than Venus under the most favorable conditions. This means, that it should be seen even by day. It would be most convenient of all to reflect light before sunset and after ascent of Sun, and this could be done twice in each 100 minutes: here a day has 100 minutes. There was produced fast and slow sparkling by hardly noticeable oscillation of mirror. At the nearest places of Earth this sparkling of the visible new star should be easily comprehended and read by the Morse alphabet.

34. State of Humanity in 2017*

What was our Earth like in the year 2017, in which our story is set?

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*Written prior to the Revolution of 1917.

On all Earth there was one beginning: congress, consisting of elective representatives from all states. It had existed already more than 70 years and resolved all questions concerning humanity. Wars were impossible. Misunderstandings between people were settled by peaceful means. Armies were very limited. Actually, those were armies of labor. Population, with happy enough conditions in the last one hundred years, was trebled. Trade, technology, art, and agriculture attained significant success. Huge metallic dirigibles, lifting thousand of tons, communicated, transported goods conveniently and inexpensively.

Especially beneficial were the huge air ships, sending inexpensive loads, such as trees, coal, metals, and so forth downstream with the wind almost for nothing. Aircraft served for especially fast transfer of small number of passengers or precious cargo; the most commonly used were airplanes for one or two persons.

Humanity marched peaceful on the path of progress. However, fast growth of population forced all thinking people and rulers concern.

Ideas regarding the possibility of technical conquest of use of world deserts were considered long ago, — still more than one hundred years ago. In 1903, one Russian thinker wrote a serious work on this matter and proved mathematically, on the basis of the scientific data of that time, the complete possibility of settlement of solar system. But these ideas were almost forgotten, and only our company of scientists revived them and partly carried them out.

35. Strange Star. Earth Recognizes That World Deserts Are Open for Humanity

A great number of people began to see before sunrise or after sunset an unusual phenomenon: a fast-moving bright star, which almost every second vanished and appeared anew. At first one took it for a dirigible, signaling with an electrical light. But it could not have been taken for an air ship, because dirigibles had to have at night several constant and very strong lights; furthermore, signals already deciphered indicated strange, absolutely unexpected things.

There were earlier rumors about a celestial ship, founded on principle of rocket, flying away from Earth, but they were considered as a joke, fantasy, of which there was a great deal. And suddenly there is read a telegram with the following content:

"Ten April 2017. The first of January of this year we, the undersigned, in the number of 20 persons, departed on a reactive instrument from a site located in the Himalayan Mountains (that's where). Now we are flying on our rocket around the Earth at a distance of 1000 kilometers, making a complete orbit in 100 minutes; we constructed a large greenhouse, in which there were planted fruits and vegetables. They already have given us several harvests. Due to them we are well fed, are alive, healthy, and absolutely supplied for an indefinitely long time. Around us there is infinite space, which can feed infinite billions of living creatures. Come over to us, if the surplus of population burdens and if terrestrial life is burdens me. Here is literally a paradisal existence, especially for the sick and weak.

For details we will turn to the place of our takeoff, whereto is delivered detailed information about our good fortune. There you can find complete instructions for the construction of reactive instruments necessary for flight." Names and surnames of known people followed.

These telegrams were received by simple telegraph operators and were printed in all the newspapers. The wonderful blinking star was also seen by all. The scientists, the academies, studied it. They determined its distance from the Earth, time of appearance, elements of motion, speed, etc. Everything confirmed the telegram. Could indeed the mystifying dirigible have flown 1000 kilometers from our planet! Agitation among the people was such as if there was declared a early doomsday. But the excitation was a joyful one... What prospects were opened to humanity!

Each nationality, besides their mother's tongue, was in free command of a language common to mankind. There was a common alphabet, certain common laws, uniting

people of the most varied mannerisms and characters. News about world events freely spread to even the most provincial corners of the Earth. Airships, frequently simply with tailwind, carried newspapers, books, preachers, and lecturers cheaply.

Everyone participated eagerly in the life of Earth. The discovery of accessibility of the world deserts was especially joyful. Who did not dream to move to freedom! The sick hoped to be cured, the old and the weak — to continue life. Our Himalayan anchorites were the center of interest, source of joyful news and information after which the whole population of the globe clutched recklessly.

Numberless commissions of scientists and practical workers flew to our hermits to investigate on the spot all works already performed by them. Numberless schools for study of sky and reactive instruments were opened. Those completing the course emerged with a diploma of reactive engineer. New factories were constructed especially for building space missiles. Technicians, masters, workers were prepared... They worked for glory, — and not a year passed by, until there were thousands of reactive instruments ready for migration.

36. Again Beyond the Earth. Conference About New Spiral Flight Around the Earth. Mysterious Knock. Sentinel in Ether

But what were our rocketmen doing during this time? Several months passed in the satisfaction of the curiosity of humanity. Every day they received from Earth hundreds of questions and were forced to respond to them. Finally, the curiosity was satisfied. There was sent a last phototelegram to Earth with such content. "We are departing from the globe along a spiral. We will investigate the spaces surrounding the Earth. For a while we will not telegraph."

Again everyone gathered in the wardroom. Newton started to speak.

— We reported to Earth all which has occurred to us, that which we felt and what we found here. Let the inhabitants of Earth make use of this free space, sunlight, heat, sorrowless satisfied existence, and possibility to think infinitely

and to work independently and freely. We gave technical bases for realization of migration, for formation of colonies around the globe. There is no longer any need for us to remain here. But it would not hurt to prepare the way for the subsequent steps of humanity.

— Hurrah! We will fly further! — enthusiastic voices were heard.

— After all we actually did not investigate the space around Earth, — at least up to lunar orbit... This space is huge and obtains light thousand times more than the whole Earth. This we will leave to the people. Rocket and greenhouse, with their continuously ripening fruits, absolutely ensure us in material respect, — continued Newton. — We should not part with it; we will have to drag it with us with our spiral motion...

— We will start again into motion the explosive material, — said Laplace. — The rocket, like a tug, will pull behind itself a huge greenhouse.

— Now there is no need to use a strong detonation, — noted Ivanov. — Before we obtained an acceleration up to 100 meters per second which bore ten times the gravity, compared to terrestrial. This forced us to be dip into liquid and that way be saved from destruction. Now there is necessary and sufficient pressure ten thousand times smaller; a second acceleration of one centimeter is enough...

— From this, — said Franklin, — the relative gravity will be a thousand times less than the terrestrial, i.e., it will be absolutely inconspicuous. Such gravity cannot in the least way damage either the greenhouse or the plants in it. About the rocket, however, I do not talk: it is adjusted to bear a high degree of pressure.

— Our flight will not produce any essential changes in our life, — noted Laplace. — We will drop in the rocket and in the greenhouse in the direction of their long axes. In the first second a falling body will pass 5 millimeters and only in 10 seconds will drop 500 millimeters or half a meter. In 100 seconds it will pass 50 meters, i.e., half of the whole length of the rocket. We will have the pleasure to stand and to walk, although all this is difficult enough. It is sufficient to sneeze, to cough, make the least motion by hand, leg or other member,

in order to break off from this stand and most successfully fly away. Man weighing 100 kilograms will here weigh only 100 grams. It is clear that attached and slightly attached objects, plants, and people in the rocket and the greenhouse will not break off from their places. We will fly as before, absolutely not noticing such small gravity.

— Purpose of this small acceleration, — said Newton, — is to outline a spiral around the Earth and to inspect space around it as well as possible. Describing the spiral, we will depart further and further from our planet, nearing the orbit of the Moon. Large acceleration and strong detonating could not be conducted, since the greenhouse is not adjusted to it and would be, therefore, destroyed by the significant gravity formed. We could remove the greenhouse by parts into the rocket, but this is very troublesome, we would lose much time, and with what will we be fed? There are no more reserves. And fruits picked at the last moment before its disassembling would not suffice even for two weeks. Probably, even more time will be needed for disassembly, restoration, sowing, and ripening of fruits...

— Even this acceleration (1 centimeter) is much, — continued Newton. — Actually, it will require 200,000 seconds, or nearly 1 1/2 twenty-four hour days, to obtain an increase in the speed of the rocket of 1 kilometer per second. Here the rocket will make more than 10 turns and will depart to a very significant distance from the Earth. Due to this withdrawal the speed of rocket in reality will decrease. Near the orbit of the Moon it already will constitute only 1 kilometer per second instead of the present 7 1/2. But then the gravitation of terrestrial mass will be almost surmounted... Sometimes we can stop the detonation, but sometimes accelerate it, — concluded Newton.

— And why couldn't we fly directly from the Earth around the Sun? — objected one of the assistants. — What we can encounter special around the Earth? Isn't the space around the Sun and further more interesting in the orbit of Mars and small planets? There, at least, the space is million times more extensive than this backwood place between the Earth and the Moon.

— Well said! — from all directions laughter and exclamations were heard. — To him already the place seems to be a backwoods — a space a thousand times more than the earth's surface...

— Independent flight around the Sun, without Earth, is fully possible, — said Franklin. — But caution does not hurt... it is not harmful to inspect the space around the Earth still a little better. Is it suitable for residence of man, won't some mass disturb its colonies? That — we will still succeed... The proximity of the Moon is interesting... Maybe, and we will also visit there.

— This is curious... Let's do it!.. everyone revived around.

Suddenly, absolutely unexpectedly, there resounded a loud knock. All looked back.

— Gentlemen, who knocked?..

But the knock was a strange one, unusual, as if someone knocked from outside. Many became pale, others approached the hatches.

— Gentlemen, — shrieked one of the men looking at the windows, — some object departed from the rocket; did it knock and rebound?

Others to look.

— Yes this is an aerolite. — said Ivanov. — more correctly, a celestial stone, a little planet or a particle of a comet...

The stone departed slowly and became less visible.

— While we don pressure suits and flit outside, the fire-ball will travel far and probably we will not find it, — said Newton.

— It seems to me, — offered Laplace, — it would be well, if one of us in a pressure suit constantly stayed on duty near the rocket. We should catch these celestial bodies. The material can prove useful to us. Iron, nickle, carbon, and oxides, — in a word, all the substances of which these tramps consist, all will be put to work...

The proposal was approved, turns were designated, and one of the participants now went on duty.

— I think, — said Newton, — that the stone which frightened us is an Earth satellite. Since th. blow was very weak, obviously, this is one of the little moons of Earth, revolving around it with a speed conformable with the distance. To be exact, this speed should be close to the speed of the rocket. This means that the relative speed of the stone with respect to the rocket is close to zero. Such celestial bodies are not dangerous to us. Their blows are not strong. But here cometary fire-balls can smash to smithereens the rocket and greenhouse... Such a case — i.e., a collision, — would be amazingly rare, of small probability, as the impact of an aerolite on the roof of a home on Earth. The danger to us is as much, as the danger of the impact of a fire-ball on the head of a man, walking along the globe. And there is no need to set a sentinal for this. No one on Earth fears aerolites. But perhaps the se..tinal will succeed, with the help of a good telescope, to see for hundreds of versts significant mass. Then it will be possible to capture it and to use the material.

— If danger is absent — said Ivanov, — that is the sentry needed? It will be enough to observe from windows on various sides with the help of telescopes. For this will be found volunteers. We thus very readily stare in windows. Anyone who notes anything interesting will speak and hunter immediately will set off in pursuit of an interesting fish.

They recalled the sentry, for which he was not sad.

37. Flight Along a Spiral. Travel Impressions. Fireballs. They Attain the Orbit of the Moon. Resolve to Fly to the Moon

For detonatings there were used two symmetrically located pipes with the most insignificant consumption of explosive material.

Detonating was almost not audible; one quickly became accustomed to it, as to the ticking of a clock. With curiosity they looked to the sides. They saw the same black sky, gigantic grayness of the Earth, the brilliant dark-bluish Sun, a

mourning sphere, covered with a silvery rash of nonglimmering stars. At first they were amused by the phenomenon of weight and falling, they had fallen out of the habit. But the force of a fall was so insignificant that it had absolutely no influence on the usual flights and games in the rocket. One could see, how sluggishly a stream of water poured, how it assumed a horizontal surface in vessels, how huge lazy waves were formed, how strikingly slowly a pendulum swung; the timepiece on the wall went 32 times slower than on Earth.

Before, when travellers emerged carefully in pressure suits from rocket without pushing off from its walls, they did not depart from them, and with a shock, departed evenly. Now they fell away from the rocket at one end and pressed against it at the other. The situation was the same as that inside the rocket. In 100 seconds a man, or any object, moved away from it, by 50 meters: in 1000 seconds, by 5 kilometers. Speed grew proportionately with time, so this was not to be trifled with, and one should be held on a leash. There was a pull on the chain, but, of course, this was hardly noticeable. If one moved by force of shock forward from the front part of the rocket, then one flew with even deceleration and a thousand times weaker than from terrestrial weight, and, finally, fell back, returning to the rocket. It was possible to strengthen the (propulsive) detonation: then all phenomena were more noticeable. But it was impossible to obtain great weight, since the greenhouse, not adjusted to that, would not sustain it.

— It seems to me, — said one of those watching for fire-balls, — that the Earth and the continents and seas visible on it seem to be decreasing in dimensions.

— This is the natural consequence of our spiral-path motion and departure from our native planet, — noted Ivanov.

The day night period became longer, but the night, while being absolutely increased (due to deceleration of rocket), became all the shorter as compared with the day. With every turn around the Earth the lavish night dawn, a crimson circle almost filling the sky, became even less and weaker. It was absolutely light, but no longer as before... The Sun flooded all without change.

All twenty men vigilantly watched in weak and strong telescopes, sitting at the well-polished windows of their cabins. They began to see small fire-balls, several centimeters in diameter, but they did not catch them, since they flew too far out. But here they became even more and larger; certain of them hardly moved. This meant that their motion was in accordance with rocket, i.e., in almost the same direction and with identical speed. They did not miss these; they caught them and moored them to the rocket. But not a single fire-ball came closer than several kilometers. They approached them in pressure suit with small reactive instrument, overtook them and grabbed them with a net. A respectable collection was amassed. Analysis found in them the following substances: iron, nickel, silica, alumina, oxide of calcium, feldspar, chrome iron, iron oxides, graphite and other simple and complex substances. Most frequent were iron and nickel in pure form and flint.

Showing the group the collection of uranolytes and reporting on the results of chemical analysis, Newton exclaimed.

— This is excellent material for buildings, here is lacking oxygen and here soil for plants. Oxygen, indeed, is in compounds with other substances, but there is nothing easier than to separate it in gaseous form; after all we have such a mighty source of energy — the Sun. Temperature in focus of mirrors can reach 5 thousand degrees Celsius...

— We have lost very little oxygen and water vapor, — noted Laplace.

— And water may be obtained from these stones, — said Franklin. — Indeed, certain of the feldspars and flint contain constitution water.

It is remarkable, — noted Ivanov, — that all these minerals and elements are well-known to terrestrial mineralogists, since they exist in the rocks of our planet. They are found, of course, also in aerolites collected on Earth and stored in local museums...

— If this world is so near in composition to the terrestrial, — exclaimed Ivanov, — that they cannot serve it as a dwelling for man or an arena for his activity?...

The further they traveled from Earth, the more stones they encountered. Dimension of fire-balls now reached several meters, but such massive ones were left alone; their mass would hamper the motion of the rocket. Sometimes something like a shadow rushed far off — cometary stones rushing with terrible speed. The more distant and huge ones rushed over the black sky like stars, although they were infinitely nearer. Fire-balls located between the Earth and the rocket ordinarily moved faster than the rocket, and those further out, slower. There was an illusion that the rocket was motionless and the fire-balls, it would seem, moved in various directions. Noting this, one of young participants of the expedition proposed to use relative motion of fire-balls in order to accelerate or to delay the motion of rocket without consumption of explosive material.

We need only to link up with them, — said he.

— Thought is excellent, — noted Laplace, but, unfortunately, we can not use it now, for want of suitable attachments. Rocket, probably, would sustain the shock; we, immersed in liquid, would survive — but the greenhouse unavoidably would be destroyed...

Earth continually decreased, the day increased; night set in somehow unexpectedly thanks to the long day, and was made greater than before by a simple solar eclipse, continuing, however, a few hours. But then day contained already more than ten terrestrial twenty-four hour days. Moon now decreased, then increased and finally became huge, interesting. There came a moment when its maximum dimension was leveled with the dimension of the Earth. The latter did not oscillate in magnitude for twenty-four hours, i.e., the time of a revolution of the rocket around the Earth, but in general it strongly decreased thanks to the motion of the missile away from it. The Moon grew enormously during half of the local day, attained a maximum, and then also shrank rapidly and seemed even smaller than from Earth. The Earth and Moon obtained equal apparent diameters when the rocket was between them at a distance of 4/5 of the total distance between the Moon and Earth, which constitutes about 48 Earth radii... But also this moment was passed...

Grows cloudless day; flowers and fruits rejoice, never lacking sun. In moments of opposition of Earth and Moon the latter one already becomes larger than the Earth. The influence of Moon on the motion of the rocket becomes all the more significant. Its speed is now increased, then so much decreased by the attraction of the terrestrial satellite. The orbit, or path way, of the rocket is distorted. It can even fly to the Moon. But before this [it] still did not arrive.

However, finally, rocket, and Moon have one orbit, move with identical speed and, rushing to one side, on opposite parts of the same circumference can not meet.

Nights already are lacking, and there are only solar eclipses — as rare as lunar eclipses on Earth. It is possible to say, that continuous day has set in.

Detonating is ceased, far from the Moon, and it seems even smaller than from the Earth.

The time of a revolution of the rocket around Earth is the same, as [that of] Moon, i.e., synodic (relative to the Sun); it constitutes about 30 terrestrial days. Not at once did the relative immobility of the Moon set in; with removal from Earth, the rocket more and more slowly overtook the Moon. while it was not absolutely leveled with her in course.

This occurred, when it reached the same distance from the Earth as that of the Moon.

Then distance between rocket and Moon was made constant. And since rocket seemed to the inhabitants to be motionless, then the same was true of the Moon from Earth; however, both outlined a path between stars, though it seemed that the stellar arch moved.

38. Doubts. To Fly onto the Moon?

Now space between Earth and Moon 360 thousand kilometers around the Earth, was sufficiently inspected, found absolutely safe and almost free from fire-balls.

People could start their migration. To Earth there was sent a telegram of corresponding content. With the flat mirror for telegraphing, it was necessary to use large dimensions, — namely there was actuated a square mirror with 10-meter sides. A return telegram advised that the Earth had received the good news.

— Humanity now will move, — stated Newton to a fluttering meeting. — We have to discuss the question of our further activity. Now we can be almost calm, we have accomplished our plan, detonation has ceased, we are at the distance of the Moon, it is safe for us and cannot noticeably disturb our motion, we are ensured vital products as before. Our position has changed only with respect to the Moon and the Earth; to Sun and stars it remained constant.

— By means of new detonating, — said Laplace, — we can go further along three paths. We can descend to the Moon and investigate this earth satellite, determining its value for Earth and society. We can, by means of firing, obtain a speed which forever will remove us forever from the Earth and set us in motion along its orbit around the Sun. Thus we can survey space around our brilliant luminary, which is billions of times more extensive than the surface of the Earth... At last, it is possible to obtain negative speed, i.e., to lose the speed which now have relative to the Earth, and then we will start to drop to Earth under the influence of force of its gravitation. After five days of accelerated drop we will be broken to smithereens against its surface.

— Well, this is least desirable of all, — resound exclamations.

— Journey around Sun can also be postponed.

— Why not try to land on the Moon? — come from many sides.

— This is feasible, — said Newton. — But we cannot take the greenhouse to the Moon, with retarded motion at the surface of the Moon, in the rocket and greenhouse there will be developed a relative gravity no less than the gravity of the Moon at its surface, i.e., no less than one sixth the gravity of the Earth on its soil. The greenhouse will not bear even such weak gravity...

— Consequently, — said Franklin, — the greenhouse must remain here; we must

fly in the rocket and be fed by reserves of fruits and oxygen. Thus, we cannot stay for a long time on the Moon, especially, if all of us go. To leave someone in the greenhouse is also impossible, because one cannot stay in a pressure suit for more than six hours... We will state, this period can be extended indefinitely, but it would be burdensome to bear it, without removing pressure suits.

— And if we assemble the greenhouse here, load it in the rocket, and disassemble it only on the Moon. There again put it together, disassemble it and to fly back? — objected those around.

— This question has already been discussed, — noted Ivanov, -- and it turned out to be unrealizable under present conditions.

— There remains one thing, said Newton, — to all travel to the Moon without the greenhouse for a short period. Fruits from greenhouse will be intensively gathered and stored, activity of greenhouse reduced as much as possible, and regulators left which for several tens of hours can properly act, delivering to the plants moisture, nutrients, and all that is necessary for them.

The discussion of flight on Moon lasted for a long time still. Nevertheless, they resolved it positively. So that it would be easy to find the greenhouse, they proposed to attach to it a huge, slowly revolving reflecting polyhedron; reflecting light from its edges, it could be seen at a distance of several thousand kilometers...

But we will now leave our fluttering company and return to Earth.

39. Events on the Native Planet

Meanwhile, on Earth they constructed reactive instruments and parts of greenhouses, made new experiments, new instruments, — the population dreamed, argued, read all that was written about the new outer space colonies. There were enemies of migrations, and those indifferent to them, and hot supporters of them. The last were in the majority. Already there appeared in the world a great number of books, especially dedicated to life beyond the Earth. With special pleasure they examined

amusing illustrations with pictures of the life of the future colonies. First of all these pictures attracted children, then juveniles and, at last, adults. Among the old men and women there were more skeptics, but young girls were attracted, although not so hotly as young men.

In all ends of Earth lectures were used, reports made at meetings, scientific societies and academies.

The first flights were awaited with impatience. There was enthusiasm when the telegram was received from our outer-space travellers about their full prosperity and the completed investigation of the space from the Earth to the Moon.

There were arguments about whom to designate for the role of the first colonists. Half of the entire population — two billion people — expressed in words their readiness, but in their souls many thought, 'Let someone else be first, and then I. We will still arrive.' Children dreamed of how they will fly about there, tumble, play, and be borne in the air and in infinite ether.

All thought about how pleasant it would be to be free from eternally stormy skies and to use constant radiance of the Sun. Inhabitants of northern and overcast countries especially wished this.

— Without night — impossible, — nodded doubting heads.

— But darkness is so easy to produce, — responded the optimists.

The weak, sick, and old impatiently coveted the Sun, although they could not approve many conditions of the new life. They passionately wished for rest, ease of movement, and tropic heat, but doubted even in the actual existence of a medium without weight. The poor enthusiastic to be freed from any need and the filth which is the inevitable companion of poverty.

— Nakedness among the naked is not offensive, — said they. — Still, if you please, who among them will be proud, who has the body beautiful, — to flirt will start — without a farthing in the rocket.

— How terrible a struggle is necessary, to conquer enemy in sickbeds, in

houses, in clothes. It is all very well for the rich to talk, but the poor and weak in most cases suffer unbearably from insects, especially in warm and primitive countries, not able to gain a full victory over them...

All were delighted by the possibility of varying the temperature from zero to 150° C.

— This means, — they said, — it is possible to have always in dwellings 30 - 35° celsius? With the resting of the body and with such a temperature, almost reaching the heat of the human body, expenditure of organism reaches a minimum, which allows man to be satisfied the scantiest diet and, in spite of this, to gain weight...

Vegetarians were contented that it would be necessary for the diet to be limited to fruits, and vegetables.

— But no one can hinder there the raising of animals, — objected lovers of meat.

— Well no! really you will not be permitted to do this there — argued vegetarians...

Polemics were raised about this in the newspapers. It was clarified that in outer space colonies there would be no highest animals. It is true, on Earth meat all more and more then was passing from use, because, on the one hand, the variety of vegetable fruits and merit of them had attained high perfection, and on the other, due to the development world trade, these wonderful fruits were all accessible. Moral currents, natural compassion, organic aversion to blood — all added up to the fact that only sick people could use the flesh of animals...

The ailing and the old sacrificed huge sums in order to accelerate the beginning of the migration. Physicians assured them that there were no better conditions for healing and extension of life, as those that are found outside the Earth: eternal sun, constant, and desirable temperature, full rest for the body, absence of blankets, beds, clothes, pressure, and contact of any sort... Least force was enough, to turn a patient to a comfortable [position]; all parts of its body always are open and

accessible, bedsores cannot be formed from lying helpless in the dampness of waste products... At last, full absence of contagion will begin...

— It is dissolute to uncover the body, — said the pessimists.

— No one will prevent you from wearing clothes, if you wish, — objected the defenders of the new life. — Besides covering certain parts of the body will be obligatory.

— Man and woman almost nude... This is impossible. — moralists were terrified.

— They will become accustomed to it. — objected the supporters. — If not, then it means that these people are insufficiently pure of soul and such are better left on Earth. Not all need be sent! Someone must remain here. The Earth will require supervision, as before; even still more strict, otherwise it will turn into a hell. To space at first we will dispatch a very few, and besides, they will be the most accomplished — in physical and, mainly, moral sense. Then will depart only surplus of population, burdening the Earth.

All were contented with the needlessness of means of communication, needlessness of struggle with weight, friction, resistance of water, air, (if one were to discount that, in the rockets and the strikingly rarefied gas in greenhouses). The journey can be accomplished undressed in rocket, but dressed — in a pressure suit, without a rocket; in both cases to rush in vacuum without stop and without any resistance of the medium.

— A rocket — the same prison, — grumbled the doubting.

— Not at all a prison, but a spacious house with all the conveniences, inaccessible now to the mightiest people, — responded opponents.

— Yes and to emerge from it is always possible; one need only to put on a pressure suit, and there already is infinite free space and freedom of motion on all six sides.

— Pressure suit is burdensome, — continued the grumblers. — The eye — is

behind glass... This the same as clothes, only still worse, more constraining...

— But up there it does not have weight, does not burden the arms, and, in any case, is infinitely more convenient than clothes of the Eskimo or Yakut. Yes, it still has not attained perfection, but when it does — you will gasp.

— Will look... On a walk there beauty is lacking; it is excessively monotonous, I do not like this sky and dead stars... Here, I see celestial azure, the wonderful sea, fascinating colors of air, mountains, valleys, woods... Various sounds please the ear, wherever I go; what may be dearer than the rumble of spring thunder, babbling of a stream, noise of leaves in oak grove, talk of the ocean surf...

— All this is so. — objected the supporters. — But how many have the time and chance to enjoy all this? On the other hand, in greenhouses there will be infinite fascination of colors, odors, and forms. And there will remain with people the power to perceive all this... The fatigued, tortured — not for them the beauties of nature... Knowledge of sciences, close acquaintance with infinite multiplicity of people not only fully will recompense, but will even exceed the lack of terrestrial poetry. This thirst can be partly satisfied by reading of books about terrestrial life, with pictures of Earth. Those living in space can even sometimes visit Earth. But, good Lord, how they will be disillusioned in it, after the celestial sorrowless life. Such a man will be like an old man longing for his native land. To him how sweet are the recollections of childhood and youth, how gratifying the paternal house, how all there are glorious, majestic, kind people... But when he goes to the native land and sees... anyone knows, that he looks and despairs...

Many said: it would be fine without weight — walls will not tumble, nor ceilings collapse, people will not drop in precipice, legs will not be wrenched and broken, it will be easy to stand, dangling arms and legs will not be gorged with blood, movement of any load will cost nothing. All this known, all already discussed. But also, gravity is necessary in many cases — for instance during washing and in the restroom.

— If you were right, in considering gravity necessary, — objected a former teacher of physics, — then after all there is nothing easier than to produce it artificially by rotation of the dwelling. There this rotation will be eternal, will cost nothing, and therefore the gravity is also eternal and costs nothing; furthermore, its magnitude depends absolutely on us — it may be either less than terrestrial or greater; the limits of its change are infinite... Here there is this advantage: on Earth gravity is constant, and here — it has any needed force, starting from zero. Incidentally, about the temperature, at very short distances from the Earth it is impossible to lower it very strongly; as the warm radiation of planet hinders this, but with distance from it this reduction can become more and more significant. At the distance of the Moon, where we find our wanderers now, temperature can be lowered almost to absolute zero, i.e., to 273° below the freezing point of water. This has huge value for industry, — continued the teacher. — On Earth the lowering of temperature is extraordinarily difficult and expensive. And out there, simultaneously and in almost the same place -- i.e., side by side, — one can obtain both 150° of heat 250° of cold. The contrast is 400°! And the absence of gases during metallurgical work?.. It is impossible to enumerate all the riches and incomparable benefits...

The Earth, — said the physicist, — thanks to its spherical surface, the change of day and night, the absorption of atmosphere — receives 8 times less radiant energy per unit of area than there [space]. Overcast and fogs reduce this figure many times more. The absence of insects and other pests, the favorable conditions of humidity and fertilizer — these lead to fabulous harvests. A greenhouse of insignificant size sustains a person with its fruits. And this with the most insignificant care and labor. Weeds, after all, are absent. They are destroyed before [planting] by an increase of the temperature to 100 degrees. And for this no fuel is necessary. In general, it is not necessary there...

— You should be an attorney, — ironically noted a physicist. — And if you

will lose accidentally all the gas from the greenhouses and dwellings, — how then? All will perish...

— It is necessary to be careful... If one were to pierce the Dutch dikes, then all Holland will be flooded.

— But loss of gases in any case are inevitable; how will you supplement them?

— And water penetrates through the dams, but this does not lead to destruction.

— And fire-balls, asteroids. They contain gases and water (in solid compounds) and building material. Any asteroid with diameter of a kilometer can fully supply a huge population for a prolonged time. Such a body would have a mass of 5 billion tons. Similar asteroids, not visible in the best telescopes under the most favorable circumstances, are plentiful enough!

— Yes, but after all they have not yet even been seen... came the objections.

— But hundreds of asteroids of 10 meters in diameter and more have been seen. Our travellers already telegraphed that they encountered many fire-balls and even made a collection of small celestial stones. Yes and we here can see, as many aerolites in our museums as we please. The less the celestial mass, the greater the number of such masses. If ten-verst planets number in the thousands, then those with smaller dimensions are much more numerous, but the power of telescopes up to now is insufficient to see them. All the more is celestial dust. It is revealed directly as shooting stars... And [it] covers, apparently, the snow of polar countries.

We cannot, of course, record all such arguments. There were frequent repetitions of the same thing, and we pass along here only the most characteristic.

40. From Earth to Space and Back. Construction of New Colonies

Rockets were built and equipped according to the already described sample. Thousands of them flew from Earth one after another — with rolling thunder, ejecting sheaves of light and evoking the enthusiasm of crowds. At first were

dispatched in them only scientists, technicians, engineers, and master workmen, people in excellent health, young and energetic, — all builders.

On the advice of the scientists, this swarm of rockets was disposed at a distance of 5 1/2 Earth radii from the surface, or at a distance of 33 thousand kilometers. Their orbital period was exactly matched with the terrestrial day. Day was almost eternal, being changed every 24 hours to a short eclipse of the Sun, in no way capable of descent during the night. Earth was visible at an angle of 16°, i.e., it had the form of a huge Moon, with a diameter 32 times that of the Moon. The latter seemed now little larger, now smaller than ordinary. The rest was as described, only on a decreased scale. The speed of a rocket with respect to the Earth constituted 3 kilometers per second.

The new arrivals in this new world at first wondered, then became emotional; but they quickly calmed down, familiarized themselves with the situation and took up the work already described above... They unpacked spare parts and erected from them a number of greenhouses. But they resolved to make them at the same time dwellings for people. Therefore the pressure of the gases in them attained one-fifth of an atmosphere. Its main component consisted of oxygen, namely — 80%; the other 20% occurred as carbon dioxide gas, vapor, etc. The absolute quantity of oxygen was only slightly less than on Earth at sea level. Action of oxygen here was incomparably more invigorating, since it was in almost pure form and not burdened, as on Earth, with a huge, awkward quantity of nitrogen. Pressure was smallish, but those flying beforehand were experienced in the ability to be satisfied by small pressure. Such a composition of the respiratory medium was profitable not only with respect to the invigorating action of oxygen, but also with respect to the smaller massiveness and great durability of greenhouses, whose shells had to bear only a pressure of one-fifth of an atmosphere. Greenhouses were not arranged absolutely identically with the one described. They were adjusted also for the life of humans; they were more durable than the former, designated for plants, with its very rarefied gas medium.

Thousands of rockets unloaded in the sky their material, descended again to Earth, were loaded there anew and returned again. Some of them remained constantly beyond the Earth, since they served as dwellings for the builders, although they were ready for a descent to their native planet.

Descent occurred along the same trajectory, as the ascent and under absolutely the same circumstances, sensations, and phenomena; however, all the speeds were reverse, since detonation in the whole time of the course acted in the opposite direction, causing the speed of the rocket continuously to fall, reaching zero at the actual surface of the Earth. Zero was attained even much earlier than contact — for the sake of safety, the rocket stood motionless, and was led in slow uniform motion, giving a non-dangerous shock at descent. While theoretically it is easy, in practice it is difficult to coincide the full stop with the first contact on the soil and, furthermore, at the desired point. Therefore somewhat more explosive material was expended during descent than during liftoff, with the same mass of the rocket. Ordinarily descended on a sufficiently extensive mountain lake, lying near the sites of ascent. From there it was simple to moor the rocket to the shore and to deliver on place.

Contingent of workers remained almost constant, since started almost first experiments of construction of colonies, and the work was very light and clean. Alloying of parts, or welding, went fast, safely, and orderly and was produced by heat of solar beams, concentrated in focus of parabolic mirror.

First greenhouse was ready in 20 days. This was long tube based on the sample described above. Its length of attained 1000 meters, and the width was 10 meters. It was described as a habitation and food source for one hundred people. For each there was 100 square meters of longitudinal section of cylinder or 100 square meters of surface, continuously (not counting eclipses) illuminated by normal solar beams. The front part, turned always to the Sun, was transparent over a third of the circumference. The rear was metallic, opaque with tiny apertures. The transparent

part, thanks to the extraordinarily strong and brilliant, as silver wire grid fused in it, could sustain absolutely safely the pressure of the respiratory gas medium and very strong impacts. The opaque [section] was still more durable. Temperature in the tubs was regulated on the outside and inside and was variable, as desired, from 200° of cold to 100° of heat, C. Main basis for this was variation in the radiating force of the external shell of the cylinder. The opaque part of it was black, but it had another folding shell, brilliant on the outside and inside, i.e., from both sides. When it advanced on the black shell, the radiation heat loss by two thirds of the surface of the cylinder almost ceased, while the flow of solar beams flooded the greenhouse and its temperature reached 100°. The reverse occurred when the second, silver shell was rolled up, gathered like a blind; then on the outside appeared the ferrous metallic shell, which abundantly radiated into stellar space, and the temperature of the greenhouse dropped. It dropped still more when the brilliant metallic shell covered the outside of glass and stopped the access of solar heat. Then the temperature dropped to 200° below zero. It fell or was increased still more, when the third, internal surface worked. Remember the Dewar vessel, in which heat and cold are well retained also, — you will find still confirmation of what has been said. Center of cylinder, its axis, was occupied by a pipe with soil; in this soil were laid two other pipes, which delivered air, fertilizer, and moisture continuously to the soil. In numberless holes in the soil pipe seeds and sprouts of fertile fruits and vegetables were planted. Cylinder was partitioned lengthwise (along the axis) into two semicylindrical sections by a silvery grid. The front, the lightest half, was only partly darkened by grape and other pilau plants growing before the windows. It served for all, without distinction of sex and age. The other half was shaded by a thick layer of rich vegetation. In it were a few, rare windows, from which it was possible to see only the starry sky, the Moon, and the Earth, giving a light a 1000 times stronger than the lunar. To these rare windows, i.e., to the purely metallic part of the greenhouse, these adjoined a row of numbers, or separate chambers. They numbered 200. One hundred

chambers were reserved for families. Further, 50 chambers were for bachelors and widowers and, finally, 50 chambers for unmarried women and widows. Every family had no less than two chambers in a row. One was for the husband, and the other, neighboring one for the mother and children. For single persons there was one chamber, but, since the number of chambers was twice more than necessary, the chambers of the single people were separated by ordinarily vacant, empty chambers. Further there was a row of locations for families, then a row of numbers for girls and, at last, — for young men. Between these quarters and the huge salon there were six long halls. Opposite the family quarters there were three halls, one for meetings of married men, another for meetings and activity of married women, and also children, and a third for general meetings of wives and husbands. Also, opposite the quarters of the loners were three long halls, two for separate meetings of young men and girls, and a hall in the middle for their joint meetings.

The never-rusting, brilliant transverse and longitudinal grids were entirely closed by thick mass of greens, flowers, and ripening fruits. The aroma filled the individual and common chambers. What could be more excellent than these rooms, whose walls consisted of greens, adorned with flowers and fruits? Through them the thin arrows of golden beams of the Sun barely struggled...

Besides the children's not one chamber was a through-passage; each chamber had one door, which could be locked if desired. The doors, for instance, from the girls' rooms emerged in hall for general meetings of the girls; from there, into the hall of common meetings of girls and young men, and from there, at last, into the hall for general meetings of all the inhabitants of the greenhouse. Attachments for works were placed mainly in general meetings, but sometimes, as desired, were shifted into the chambers.

The picture of the general meeting hall is such. If one were to stand on the green partition, considering it the floor, then the Sun seems to be above the head and there is no shade. Its action would be unbearable if not for the layer of plants shielding the causticity of its beams. In this position we see a grandiose

hall with an arched glass ceiling and flat green floor. But we do not topple into it, since weight is lacking; we cannot penetrate through it, as this is prevented by the strong silvery grid. Width of the hall is 10 meters, the height 5 meters, and the length 1000 meters. For a hundred people this is a whole desert, a luxury which is difficult to imagine. Even if all one hundred inhabitants were to appear in the hall simultaneously, then for every person there would be about 400 cubic meters of space. It is true, part of this is occupied plants, but it is small. Circumference of cylinder is about 30 meters. This means that the arch, occupies 15 meters. Its transparent part is 10 meters; it does not reach to the green carpet by 2 1/2 meter. The number of chambers is much larger than is necessary. We will present one of them. It has a height of 2 1/2 meters, and is 9 meters in length and 5 meters wide. If one were to stand in such chamber with his feet to Sun, along the flow of its beams, then he will see above his head an arched opaque ceiling with little windows, through which, large part indirectly, there stream the rays of Earth. This light is fully sufficient for reading... The six common halls have the same dimensions. Each is 2 1/2 meters in altitude, 167 meters in length, and 10 meters in width. These presentations about the height, width, and length change, depending upon the position of the observer. By imparting weak rotation to such greenhouse around its transverse axis, they made its position constant with respect to the Sun, since the plane of rotation can be held constant in direction. The weight obtained from rotation had almost no influence on freedom of motions and even was not evident; but at the ends of the greenhouses, where it had the biggest magnitude and where restrooms and baths were placed, it brought certain benefits — it distributed water in vessels and helped to accomplish exercise.

It is necessary still to mention a very important organ of greenhouse: the regulator of dampness or humidity. Plants under the influence of burning beams of Sun continuously evaporate a mass of water and quickly dry the soil. Thus, it seems that what is required in the greenhouse is a terrible dampness. But this is lacking.

The degree of humidity depends on the desire of the people. On the outside, in the shade, along greenhouse there runs a special ferrous metallic pipe — a refrigerator; air is continuously forced in it, where it is separated from liquified water vapor, depending upon the temperature of the pipe. This temperature, as we explained, can be varied extremely — it can be lowered almost to 200° of cold. Certainly, such a low temperature is not needed; a very insignificant degree of cold is enough. After heating very dry air is obtained in the greenhouse. Water obtained from condensation of vapor by steam or air or from rotation of greenhouse is collected at its ends, in restrooms and baths, where finally it is cleaned and serves for ablutions. Then it enters the soil pipe for fertilizing and moistening of the soil.

For want of weight, the air in the greenhouse does not circulate, although the temperature of the unequally shaded parts of greenhouse is far from uniform. Centrifugal force produces currents, but they are excessively weak and insignificant in magnitude. Therefore, for the sake of purification of the respiratory medium of dust, leaves, fruits, and random objects the air is put in motion by individual fans and is excellently cleaned. But the currents, leading into the refrigerator can be limited.

Builders connected several greenhouses in the form of stars and other figures, imparting to them light rotation, so that transparent half of structures was always turned to the incident solar beams.

However, we will leave out architects to create these outer space dwellings and to populate them with people, while we return to the explorers of the sky, circling now with speed of one kilometer per second along the orbit of the Moon. We will visit the migrants, when they have assembled houses sufficiently suitable for them.

41. Journey from Lunar Orbit to Moon

We left our scientists on the orbit of the Moon, at a distance of 360 thousand kilometers from the Earth. You remember that they resolved to fly to the Moon.

But at a new meeting the plan of the flight was radically modified. In order to economize fuel and not to subject to risk the greenhouse, which was the main source of their food, they proposed to send the Moon only two together, in a special rocket, set up for that. Why the huge volume, strength, and mass, if there will fly only two and if the force of detonation could be a thousand times less? Because the little rocket should be set up to motion on the lunar soil and for flight through the ravines, mountains, cirques, and volcanoes. The first is attained by addition to the rocket of wheels, revolving by stored energy, since on the Moon, it will be impossible fully to calculate solar energy. The second is achieved by location of additional combustion tubes, counteracting the weak weight of the rocket on the Moon. Wings would not help, since the gas shell or our satellite is almost non-existent.

Meanwhile, far off from scientists the colony was organized, they planned and prepared the new crew for the Moon. One engineer by the name of Nordenshel'd passionately wished to fly to the Moon. Ivanov wished to go with him. The society decided on this.

It was a moving, parting, and seeing-off. And mainly — all the stores, the machines and their operation, were strictly checked. The whole crowd, in pressure suit, escorted the small rocket, until its speed was increased by detonation; then it was necessary to lag behind, — the rocket quickly disappeared from the scene, and the natives had to return home.

Detonation was directed in the direction of motion of the small rocket, so that its speed was soon doubled and arrived at two kilometers per second. Relative weight was very insignificant; therefore, there was not need to be immersed in liquid. Nevertheless, to save time they made it equal to terrestrial toward the end of detonation. How pleasant was the involuntary tensing of muscles at rest, when lifting the hand! Faces paled from lack of blood; hands and legs were filled with it. Both to such degree resented the gravity, which they had missed before that the

change very quickly began to evoke grimaces of dissatisfaction and impatience. When after 100 seconds the phenomenon ceased, they sighed with relief and expressed no desire again to return into the medium of gravity. Conversely, they sprawled in the small space of the rocket, like people plunging into feather beds after heavy labor... Visible diameter of Moon was noticeably increased. Relative speed was one kilometer, but it was increased continuously by the action of the Moon. However, its attraction could not give an addition to the speed of more than two kilometers per second. Initial distance to Moon, counting along its orbit, constituted about 1,200,000 kilometers. In seven days this distance was decreased by almost half. If now speed is not decreased by detonating, the rocket will move away from the Moon and will quite depart from it. Therefore, the speed was cut down by detonating in the opposite direction. Thus, the path of the rocket was gradually corrected, and it again approached the lunar orbit. Then detonating ceased and relative weight disappeared. In five days the Moon was already at a distance of 200 thousand kilometers and seemed in twice larger than from the Earth. The distance decreased, and the apparent diameter of Moon was increased, which confirmed the approach. They had already earlier gazed on the Moon and were once even nearer to it than now, so that its growth did not especially bother them; but still they looked on it with trepidation, knowing that in a few hours they would be on its surface. Who knows. Maybe, if they did not manage to contrive during the descent, they will be smashed against its surface.

— Is it not time to reduce speed? — asked the Swede disturbedly, not taking his eye from the Earth's satellite.

— No, — answered Ivanov, — we will wait, until the relative speed of the rocket under the influence of lunar attraction reaches two kilometers per second.

Still much time remained. They snacked frequently and vied in regaling one another, nervously looking to the sides. They Sun was as dazzling as usual, illuminating the huge Earth, which displayed well its patterns of continents, seas,

lakes... The sky appeared everywhere black, with the stars point-like, as if dead, and a few planets. But all more and more they fixed their eyes on the Moon. Its apparent dimension already was equal with the dimension of Earth... Then it began to exceed Earth, and the latter began to efface itself.

After twenty-four hours the Moon somehow began especially to grow, being increased not by the hour, but by the minute...

— Terrible. — the Swede exclaimed involuntarily, looking with terror on the excessively swollen Luna. With striking clearness there began to appear its seas, cirques, craters, ravines, the dazzling brightness of some sort of lines and points. The map of the Moon was before them in transformed, magic, living form... There appeared regions, valleys, and mountains never seen from Earth in any telescope... Travellers looked on Moon "from the side" and therefore, half of its rear part was revealed.

— Is it not time to brake the rocket by detonating? — asked the Swede again, not restraining his agitation.

— Yes, probably so, we will start in a few minutes...

The Moon was at a distance of two thousand kilometers and was visible at an angle of 50°, i.e., it occupied a seventh of the circumference of the sky and became a real monster already for both. Its diameter was 100 times more than ordinary.

They started the braking detonation. Both anew sensed weight, but much smaller than terrestrial. They sat on the floor. Under their feet there appeared the huge Moon, in the form of an overturned, patterned umbrella, a component part of the celestial sphere...

— In half an hour we will arrive on the Moon, — said Ivanov.

The light umbrella under their feet grew and occupied almost half of the sky. Hearts of both beat disturbedly. Mountains, valleys, cliffs, craters were visible as clearly and closely as the terrestrial landscape... It seemed that a few kilometers separated the Moon from the travellers. Yes, it was so... counterdetonation strongly increased... the rocket became even more quiet...

— The rocket stands still, — said the Russian, looking in a goniometrical instrument at the Moon.

Direction of detonation was again changed; the rocket moved forward under acceleration; the relative weight changed its direction, so that Moon instantly appeared to be above the head... To the valleys and mountains spreading above them there remained only two or three kilometers... Strange was the phenomenon of relative weight. It was opposite to the lunar. Thus, the Moon seemed somewhere at a height, like a ceiling.

— The illusion was striking, and Nordenshel'd muttered.

— How we will go by this ceiling... What there will be attached?.

— Be calm. All is well, — responded Ivanov.

Rocket obtained 100 meters of speed in the direction to the Moon. There remained only about two and a half kilometers. Now the pressure of gases did equal lunar attraction. The rocket's inertia sent it along evenly with a speed of about 100 meters per second. Relative weight again disappeared, and Moon seemed now here, then there, looking in the direction of the bodies of the travellers. After 20 seconds there remained in all only 500 meters of distance. Counterdetonation was again initiated. Weight again changed direction, and the Moon now appeared to be below. Upon the expiration of another 10 seconds our heroes descended on the soil with a hardly noticeable shock. It happened this way. The rocket hardly moved here they are almost touching the soil, which passed under their feet fast enough... The rocket assumed a horizontal position; it turned and stood with its four wheels on the Moon, like a cat dropping on its paws, rolled several tens of meters along the valley, and stopped.

42. On the Mountains and Valleys of the Moon

The rocket stopped. The travellers were as if in a torpor. There was a dead silence. It seemed that they had just awakened from sleep or from a faint. At last, the Russian arose, stretched and said.

— We are on the Moon; the weight here is six times less than on the Earth. Is it not true, as this feels, — continued the Russian, waving his hands and moving all his limbs.

The weight did not surprise them, since during detonation they had frequently experienced it. But there was a difference between true weight, from the gravitation of a mass, and relative weight. During acceleration of the rocket or its uniform braking relative gravity of any magnitude, depending upon the force and direction, was formed. But since the latter could not be fully constantly in force and direction, this relative gravity was accompanied by a certain shaking, as during a ride over very good road. When relative weight was obtained by rotation, then there was felt not the least shaking and oscillation. During ordinarily, comparatively slow motion of objects and people on a revolving body this relative weight did not differ from gravitation, if one were to discount the slight dizziness to which certain people are subject during oscillation or rotation; the majority experiences nothing, especially with a large radius of rotation. During fast independent motion of people the artificial gravity obtained from centrifugal force shows very interesting phenomena, which we will describe if we have a chance. Now they experienced in full measure that which they had become accustomed to experience on Earth. And this was as gratifyingly to them, as if there suddenly appeared an odor of something, reminding them of the past, bygone sensations of childhood or youth...

— It is rather cold, — said the Swede.

— Yes, sort of.

In windows there was night. One almost could not see the ground. The celestial arch spread around. It was black, with an infinite number of non-blinking stars. The Earth, i.e., Moon could not be seen. They felt helplessness, sadness, and even fear. On the horizon there were vague outlines of dark, jagged masses. Above them — the innumerable silver fields of stars.

— And after all we are on the half of the Moon unknown to humans, where the Moon — i.e., our Earth, — never shines — explained Ivanov.

— Yes. — confirmed the Swede. — But here, of course, the Sun shines; we will await for it...

— I understand! And then we will see a place that no one has yet seen from Earth.

— But will it quickly rise? We will freeze, if this night continues for many hours, — noted the Swede.

— Sun should quickly appear, — answered the Russian. — there, see, on that side something on horizon seems to brighten. This is dawn...

— How dawn? — the Swede was surprised. — On the Moon there is no atmosphere, which means there cannot be a dawn...

— Maybe, there is a rare atmosphere, but it is not that which produces this light in the east. Mountains, illuminated by the sun, reflect their light on peaks not yet illuminated. These distribute the light further, etc. Thus, there is obtained the special lunar dawn, very weak, not like the Earthly one...

— Look, the light of dawn strengthened, while we talked, — noted the Swede, involuntarily looking out the window... — And, nevertheless, it is terribly cold... should we not start the electric heater?

— Well, o.k., turn the button, — said the Russian.

— This is still nothing. — he continued. — The cold penetrates to us very slowly, thanks to the surrounding emptiness and the brilliant double surface of our rocket. It splendidly reflects the beams of heat and does not let them escape from the rocket, either into this stellar space or into the lunar soil.

— Wait! What is this that shines in the east? — exclaimed the Swede.

— The summit of a mountain was illuminated by direct sunlight, — calmly answered the Russian.

— This means the Sun now will appear...

— Well, no. You forgot that a day on Moon is 30 times longer than on Earth. Sunrise is as much slower.

— Yes, yes. I absolutely lost this from view; if we are on the equator of the Moon, then sunrise will continue evenly for 60 minutes.

— Absolutely true, — confirmed Ivanov, — since on the terrestrial equator the ascent continues for two minutes...

They became warmer, owing to the heater, and their mood became still more placid... now is lighted another summit, now two simultaneously... It is possible already to distinguish some nearby things... Fires, during their stay on the Moon, would not light, although they tried to light them... but surrounding gloom became still more terrible, and they, therefore, extinguished them; nevertheless, from the darkness there were visible the familiar patterns of constellations, the same Bear, the same Orion with its bright Sirius, the same Milky Way stretched from one edge of the sky to the other. This encouraged them and made it possible to see almost anything. They had long ago become accustomed to the black arch...

An hour passed unnoticed while they examined the sunrise and observed the flashing summits... They passed some two hours without the Sun, and how poignant this was! First beams of it were encountered enthusiastically... They were dazzling... An ever greater and larger part of the solar circle was advanced... But it did not have a red, embarrassed form, could not be called a "red Sun"... No! This was a bright dark-bluish Sun, twice stronger than the terrestrial equatorial Sun, standing above the head. There were illuminated all the great bulks of mountains, valleys, cliffs, stones. It became lighter. The rocket stood sideways to the beams of the Sun, but was heated weakly thanks to its brilliant surface.

— Now there will be heat without the stove, — noted the Russian. — Turn, please, that handle there, so that the part of rocket, turned to Sun, will be covered by a black surface.

— Readily. — said Swede.

There had hardly passed several minutes, when it became unbearably hot.

— What, — said the Swede, — did I not extinguish the electrical heater? No, it is out...

— I am truly being steamed, — said Ivanov and he turned the handles in the opposite direction, so that the surface turned to Sun became striped, with some bands black as soot, and others light as silver. It became cooler. The handle was moved to and fro, until they obtained the desirable temperature, namely about 30° C.

— Now, finally, — pronounced the Swede with pleasure. — But what will we do now?...

— We can emerge, — answered Ivanov, — to stretch our legs in motion, which here is unusual, inspect the environment, and then we can travel over the Moon in the rocket, which can act as a carriage, rolling on its wheels. Through ditches, craters, and mountains we can pass, using rocket power and balancing by it the insignificant lunar gravity...

— Excellent, — agreed the Swede. — And how about air?.. Here the atmosphere is inconspicuous... Then, it is cold... after all before this there was a long night... The soil should be terribly cold...

— Yes, the soil has now about 250° of cold, since the Sun has not yet succeeded in heating it, — noted the Russian. — But all this is nothing; it was worse when under the feet there was nothing and nothing protected us from radiation... Soil, however cold it is, still gives more heat than open, stellar space, which sucks this heat terribly from any body...

— How do we touch such cold soil, i.e., go over it?

— We will don pressure suits, supplied with oxygen, then — special overshoes, soles of which virtually do not pass heat... Hot Sun will also warm us successfully, like the rocket. Here are striped clothes, which absorb as much solar heat as is necessary... even somewhat more.

— And why not wait, until the beams of the luminary heat the soil... — objected the Swede.

— We will lose much time; the soil is excessively cold and will not warm quickly...

They resolved to emerge from the rocket. They donned pressure suits, fastened the shoes. At first the Swede entered a narrow case or cabinet, closed the internal door after himself, passed the external door and hermetically closed it. The Russian did the same. Both were on the soil of the Moon. Near them, on its wheels, rested the rocket. Since it was not designed to cut through air, it had the form of an ellipsoid, whose length was only three times larger than its height. It reminded one of an old-fashioned, very original coach.

Everything around shone and sparkled under the beams of the Sun. Far off towered the great bulk of mountains. They stood on an even and smooth enough plain, carrying for people the name of "sea." The Sun warmed them; they did not feel the cold of the soil. In pensiveness they stood for several minutes, looking around them. The turning about happened willy-nilly, since otherwise one side became hot and the other, shaded side, cold.

Contemplation of the original, unprecedented beauties, lightness of body, and the bright, warm Sun brought them gradually to an enthusiastic state. The Russian rubbed his hands, put them to his breast and shivered from joy. The Swede jumped in admiration and rose to an altitude 4 meters. He flew there and back for a whole 3 seconds. The Russian ran, making huge jumps — 3 meters high and 12 meters long. During the run the length of his steps was increased still more, and he leaped cracks and ditches 24 and more meters wide. Both lifted stones in their path, and they seemed in weight to be wooden or hollow. Six poods of granite weighed here only one pood. Stones cast upwards rose six times higher than on Earth, and arrived back very slowly, so that it was dull to wait. They flew 6 times longer than on Earth. In the horizontal direction their path was also 6 times more prolonged, compared with the terrestrial. The Sun rose completely, but very slowly. Shadows were very sharp, but not fully black, since they were illuminated by the surrounding illuminated mountains and hills. To stay in the shade more than several minutes, was impossible, since one standing in the shade was deprived of solar beams, i.e.,

of flow of heat; he only lost heat and therefore fast cooled and hurriedly jumped, with huge pleasure, into the sunlight. Both travellers easily jumped over one another, and also without effort lifted one another. Jumping upwards, they contrived to turn over several times during flight; however, they did not land on their feet and were injured slightly against the ground. They enjoyed gymnastics, running about, acrobatic jokes — like children; and they turned attention insufficient to other things. But they became tired of gambolling and playing. The Russian bent and stirred the soil with his foot. It was covered with a thin coating of dust; under it was something hard, like granite. In other places the layer of dust was thicker; there were drifts of significant thickness; some were soft, others were compressed and denser, and others were quite solid. Special thermometer made from a metallic rod showed in the depths of a drift about 250° of cold. From above, the drift was already slightly heated by solar beams. In higher places granite masses were bared. On every step one found stones, seeming very light. Far off there were great numbers of scattered big granite chunks. A great number of cliffs were visible, and still further away, hills and mountains. They appeared to be very close and small. Everywhere there were cracks, especially in bare granite; many were narrow, hardly noticeable: behind the narrow ones followed wide ones, reaching several meters in width. There were also ravines. In the drifts there appeared a great number of roundish holes, large and small. Our friends ran in various directions, looking at everything, and jumped without effort over huge stones and enough wide ravines; they frequently drew together in order to exchange impressions. To talk directly was impossible , due to the extreme rarefaction of the atmosphere; they had to either touch helmets or to stretch between them a steel wire. The soil of Moon did not transmit their voices, since their soles poorly passed sound...

— I am always surprised, both here, and in open celestial space, — said the Swede, — that we see, as it were, an "arch." Air is lacking — whence the arch at least black? Flammarion negates [the existence of] an arch on the Moon...

— No! I understand this illusion, — objected Ivanov. — The eye considers all huge distances identical. Therefore, stars, Sun, and Moon seem to us to be at one distance, i.e., as if fastened to a spherical surface, of which we are the center. Hence the illusion of an hemispheric arch. On Earth it seems blue and flattened from above, because on horizon the thicker layer of atmosphere darkens stars and terrestrial objects. We in general became accustomed to consider objects to be the further away, the more they are darkened from black-out by their air. That is why the arch on Earth seems flattened, as is not true either in space or here... Here air is lacking; there is no black-out of stars and mountains. This is why they still seem to be close by and toy-small. Something similar, although in smaller degree, is observed on very high terrestrial mountains; there also all seems nearer and smaller than at lower levels.

When the travellers looked in the direction of Sun, then stars appeared to be fewer, due to the narrowing of the pupil under the influence of indirect sunlight; it was the same when before them sparkled the illuminated slopes of mountains. Conversely, from low places, from which fewer illuminated surfaces were visible, and from shadowed places, especially from pits and ravines, one could see as many stars, as at night.

Sun rose very slowly, moving every hour only its own diameter. It would require 180 hours to attain zenith. Shadows were still huge. To depart far from rocket was unsafe. In deep craters there would be shadows, and without beams of Sun it would be very cold. Our friends did not feel like expending thermal energy.

They tried anew to descend into one of the ravines. The edges were noticeable; in the depth there appeared an infinite black abyss. They found on the side a sloping section, and started to descend. When the gloom began to absorb them and above their heads were lighted infinite points of stars, they lit bright electrical lamps. The reflector illuminated the wall, which were here and there speckled by some hieroglyphs. The walls were warm; at a depth of 5 - 10 meters the thermometer showed about 20° C. The Russian touched the granite rock and noted that the stone

was similar to our written, or Jewish, granite, containing little mica. They descended lower; the temperature remained almost unchanged and was quite warm. At a depth of more than one hundred meters the walls became still smoother and shone all the more with the measure of their descent. The Swede rapped on an especially shiny part and exclaimed,

— And after all this metal! Look how it shines!

— The deficient oxygen could not oxidize lunar crust to a large depth, — responded the Russian. — It gave granite from surface; the internal mass of the Moon contains nonferrous metals or alloys. This crack, in which we are, obviously, was formed after the disappearance or, more correctly, absorption of the atmosphere by the lunar mass.

Samples of rocks and metals selected at various depths were lifted to the surface from a depth of 1000 meters. Like the descent, so also the ascent was unlabored. The four-pood Swede felt himself to weigh only 27 pounds, and the Russian, weighing less, — only 24 pounds. Also the pood of their load of minerals and metals constituted all 6 pounds. There was in the ravine neither dampness nor humidity; they did not sense them, since they breathed an artificial composition, which was packed on their backs.

It was necessary to rest, to eat, and our friends with their precious load were enclosed in the rocket. Resting, eating, and resting again, they donned the pressure suits and as before went outside.

Under terrestrial gravity, motions are quite tiring, but they are freer than in ethereal, unlimited space. This motion can change every second. Here is not only freedom but also absence of fatigue, thanks to small weight. Only the pressure suits are somewhat constraining. But then what a new world! How much variety and unexpected discoveries!... It is clear that our travellers not only felt well because they had plunged into something familiar, similar to Earth, but also because to this were added the satisfaction of [being] the first explorers of the Moon, the inquisitiveness of scientists, and simple curiosity.

The Sun rose still higher — to 20 degrees; the shadows became shorter, the soil warmer. Slopes perpendicular to beams of Sun became quite warm. They ran to the nearest hill. They ascended to the summit and had to stop before a precipice. They stood before a cooling crater. There the gloom was still deep, and the bottom was difficult to discern, but in the center of the dark circle there shone some point, very likely the summit of a mountain, illuminated by the Sun. They resolved not to descend into the crater itself, but ran around it. Certain places descended slopingly on the outside or inside, others — precipitously. Here were cave-ins, and below appeared the piles [from the] cliffs, their fragments, stones, crushed rocks. In general, steepness to interior of crater predominated. Beautiful columns of basalt were frequent... They returned, gathering a collection of porphyrites, basalts, trachytes, lavas, syenite, hornblende, feldspars.

— What is this — it seems as if something flashes in the cracks and is concealed, — said the Russian.

— And I also noted it... — confirmed the Swede.

They began to look more attentively in the cracks and holes. All the more and more frequently there appeared this flashing; far off passed there flickered some sort of shadows which were hastily concealed. First one, then the other ran fast in the direction of these visions, but they disappeared without a trace at their approach. At last, the Swede grabbed the binoculars and applied them to the flat glass of his helmet.

— Yes, this something living! — he exclaimed. — here [one] runs over field... there [one] hid in a hole...

— Give me and I will look, — Ivanov turned to him, snatching with impatience the binoculars from his hands. — Look, look... They are green... On the backs there are some sort of twigs... Well, truly, they are similar to moving bushes... We must seize these creatures...

But now they did not manage to do this; the quick animals were quickly concealed as they approached. As the soil warmed more and more of them appeared.

Some were heated motionlessly in the sun, other crossed sites between burrows. They were of a miscellany of forms and extremely varied dimensions and colors; most were green, but some were red, yellow, orange, and black. Some were polychromatic. Some had points of glassy brightness sparkling on the surface of their bodies. The smallest ones dug in dust and were as if swallowed by it; the larger ones chased after the little fellows, caught them, dragged them in their burrows, and, perhaps devoured them...

— Temperature on Moon, — said Ivanov, — theoretically should vary from 250° of cold to 150° of heat. It is clear that plants with such cannot exist on the soil of the Moon under such nightmarish conditions. I did not mention the absence of sufficient moisture and sufficiently dense atmosphere.

— Certainly, that is so, — agreed the Swede, — but you imply the usual motionless plants, as on Earth. If a plant attained a certain intelligence or even instinct and the ability to move, then they could live on the Moon. We cannot negate such ability for plants on the basis of all known factors — for instance, the insectivorous plants of Earth. When it is very cold, nothing would stop them from hiding in deep ravines, where the temperature is medium, i.e., on the equator about 22° of heat Celsius, and in highest latitudes less. When it is very hot, i.e., at the end of the long day, again the deep lunar cracks could be their salvation.

— Not once have I seen here the usual plants — with roots. Immobility, of course, would kill them during the terrible contrast of temperatures, — noted Ivanov. — If such plants were hidden in deep ravines, then again they would perish from lack of sunlight.

— I also have not noted plants similar to terrestrial.

— These moving plants, it seems to me, — said the Swede, — are similar to marine creatures with green chlorophyll. Some of them, the smallest and microscopic, live exclusively by the Sun, like plants; others — larger — both use the

Sun and consume the smaller creatures. Here there is accomplished the very same as in terrestrial oceans, only there is no water and substances dissolved in it...

— But here there is dust containing oxygen, carbon, hydrogen, and many other elements, necessary for the living world and consumed by them... Sun transforms them into water and the various compounds of which living matter consists.

— The covering of their bodies, poorly permeable for gases, protects them from drying, — noted the Russian. — They obtain energy from solar beams or absorption of other animals, and more frequently the one than the other; thanks to it they move and somewhat think...

— Their chlorophyll, under the action of solar beams, decomposes carbonates and other simple compounds into carbon, oxygen, and so forth, which, being combined, give all the complicated tissues of the body, — added the Swede. — The tissue of the body, being decomposed during muscular and metal work, give simple compounds, subject to excretion for our animals; in these creatures they are not rejected, but again are processed in terrestrial adjuncts of body by the power of solar beams into tissues, etc. It follows that the animal, after birth, does not eat, i.e., it takes in no external matter — neither organic nor mineral.

— There is no time to reason on this subject, and even less to do experiments. It is necessary to ride around the Moon, to ascend from it and to be reunited with our friends before we exhaust our supplies. There the greenhouse presents inexhaustible supplies. Not for us are the local creatures; it is possible they are poision, yes and we do not know how to catch them...

— I think, — said the Russian, — that we should ride not inside the rocket, but on its upper side, having for this purpose rails, seats, and an easily raised canopy.

— More interesting to ride eastward, toward the Sun, over the unknown half of the Moon; first we will encounter more and more heated soil and, accordingly, more awakened life, and secondly, the long lunar day will pass faster, the Sun will set, and it may be possible to observe still other interesting phenomena.

— Yes, yes. — said the Russian. — We will rest, yes and then on the road... We will collect more minerals, supplement our collection...

In a few hours, very quietly collapsing in easy chairs on the upper side of the rocket, they had already rushed to the ascent almost along the equator of the planet with a speed of 10 to 100 kilometers per hour, depending upon the state of the path. They sought, of course, the valleys, flat-bottomed, passing by the gigantic mountains and traveling around even small craters and hills. Their course happened to describe a complicated enough line, and the Sun illuminated them now on one side, now on the other and even from behind. But the pressure suits protected them from the murderous action of the solar beams. Wheels turned fast and directed their way now to the north, now to the south. Little cracks were passed without difficulties, large jumped from a run, and those of magnitude of several hundreds of meters (and sometimes even several kilometers) they had to fly over, with both strongly clinging to the railing, not forgetting to control the mechanisms. At the sight of a precipice while still far off, they started the combustion tubes, which counteracted the slight weight of their carriage and rushed them with tenfold speed past ditches, ravines, small craters, and mountains. But to this they resorted rarely, since they had to economize on explosive material.

Owing to their fast motion eastward, the Sun as if revived and rose fast. At an hourly speed of 15 kilometers the motion of the Sun along the horizon was accelerated twice, i.e., it passed each hour not half a degree, but a whole one. At 105 kilometers the Sun passed already 4 degrees per hour. Such a speed made it possible to cover half of the equator in 45 hours.

— Will you look at that, — noted the Swede, — the Sun has begun to fall eastward!

— This is because we have now turned in the opposite direction and are tearing along, so as to bypass that mountain, westward.

— You mean, here it is possible to govern the sun's motion, to force it to

set, to rise, to move faster or slower, to stand in one place, to ascend on west and set in the east? — said the Swede, looking on the lavish landscape.

— Absolutely correct. — responded the Russian. — The cause is simple: the Moon is small, and speed of motion of its equatorial points is still less. They pass less than 4 meters per second or about 15 kilometers per hour. If we were to move with such speed on the equator of Moon, but in the opposite direction, then our rotation would be destroyed, and the Sun would stand eternally (so to us it will appear) in one place. If we are then on the night side, the gloom will be constant; if on day side, then the light will be constant. At some other independent speed, it is possible to force the Sun to move faster or slower and to ascend or to rise unnaturally or unusually...

Every three, four hours they had to stop, in order to eat, to rest, and to check the pressure suits. For that they entered the rocket. Having rested, they gayly jumped, ran about the environs and gathered samples of rocks. Precious metals still were not found. They stopped more frequently when something caught their eye. Sometimes along the edges of a huge ten-kilometer steep mountain behind them they saw unbearably shining and sparkling cave-ins. Huge stones, cliffs, and whole mountains collapsed from multikilometer altitude and, not encountering resistance of air, fell with terrible speed and were broken into small parts. If this grandiose drop was recent and heap was not obstructed by alluvial dust, then cave-in was fresh, exactly washed, shining with all the colors of the rainbow. Beams of Sun, being refracted in transparent crystals, gave an interesting spectacle. Cause of cave-ins is very clear, although on the Moon there is no dense atmosphere and abundant water, which by their motion and freezing greatly promote destruction of rocks on Earth. Here the main cause of destruction is the huge difference of temperature of day and night, attaining 400° C. This produces even more deeper cracks once in smooth mountains. Then, if steepness is sufficient, the first cave-in occurs; after it, for the same reason, there are more, etc. When

along the edges of mountains there are formed thick enough conglomerations, then they prevent further cracking of the stony soil, and also the steepness of the mountains decreases so much that cracking summits remain in place. Many mountains on the Moon had already attained this state and now suffer little destruction and falling; however, there remained still a great number of cirques, on which this destruction was continuing. Our friends more than once felt a seeming earthquake from grandiose cave-ins, and sometimes even saw them, but sound reached them only through the ground, since it was badly propagated in the atmosphere in view of its low density...

Shone the dark-bluish Sun, hidden from them by the rocket canopy, but it did not hinder by their view of the black hemispheric dome, studded with familiar constellations. Only the light reflected from the mountains decreased the number of visible, unblinking stars. Around was dead silence, if one were to ignore the noise of the rocket motors, which was transmitted through the walls and seats to their bodies. Nowhere could one see small clouds, nor trees, nor grass; only around them something green would flash fast and be concealed, scared by the motion and noise of the rocket. These were the lunar animal-plants... The eye was terribly affected by the absence of woods, green meadows, lakes, rivers, snows, and azure air.

— Look, — said Russian, — what is this which moves toward us? Like some green cloud... Look there, where the highest cliff appears...

— I see, I see! This, probably, is a herd of the local animals...

The Swede brought to his eyes the binoculars and indeed saw a great number of jumping, kangaroo-like animals, being frightened by the rocket, swiftly dashed aside and disappeared behind the neighboring mountains... Later on our travellers many times saw the same thing and resolved that not all lunar creatures hide from the cold in ravines and cracks, but many, the biggest and strongest, use the eternal day and heat of Sun and soil, racing after the light and conducting all their lives in motion. Along the way they catch and devour weaker animals. Their motion is westward, so that they would never miss the Sun, should be close to 14 kilometers

per hour. Under weak lunar attraction this continuous and moderate motion fully is possibly and even easy.

During stops, walking along cave-ins near steep and even vertical granite masses, they picked up the things that most appeared to them, finding transparent quartz in the form of huge crystals or rock crystal; reddish orthoclase and dark hornblende lay about in great numbers; now and then they found zircons, garnets, and tourmalines. Around stood by columns, still not destroyed, of green stone, reddish porphyrys and splendid basalts of various colors; at their bases our friends and were repeatedly aroused to enthusiasm by beautiful examples of stones. They filled a basket with red rubies, orange transparent hyacinths, dark melanite, blood-red pyrous, violet almandine, sapphires, emeralds, and amethysts. They found also diamonds of various colors, small enough. Rocks crystal was frequently milky, pink and other colors. There was much hydrates (water compounds) of quartz, chalcedon shone by beauty red carnelian, green, with red spots, heliotrope, and agate.

Once they saw far off a mass white as snow. When they approached it, then between fragments of gneiss and micaceous schistose they saw a field of diamonds, among wh'.n there were some the size of a fist.

— Here is all the wealth, which is lacking for all people together. — exclaimed the Russian, but his friend, of course, this did not fear, since they did not touch helmets.

Greedily the travellers jumped on this treasure: it was necessary to discard from the baskets many wonderful stones, in order to make places for the most fascinating samples of diamonds.

Terribly loaded, they gayly reached the rocket and entered it...

Many were the diamonds — they even gathered a little gold sand — but foodstuff reserves that remained were now small. They had to fly away from the Moon, not investigating, as much as they wanted, its world. Resting, consuming bananas, nuts, pineapples, quenching their thirst with watermelons and grape juice, they gayly

sorted their treasures, poured through their hands aquamarines, emeralds, and diamonds, and looked in the window.

— All these jewels, except for the gold, which here is so scarce, — said the Russian, — are now only a mineralogical collection. Really, with the accessibility of the Moon and its stones, diamonds will be depreciated on Earth...

— Look, there to the left there burns a bright fire. — exclaimed the Swede.

The Russian looked back and saw a sheaf of fire on one of the lunar hills. After several seconds there was audible a sharp rumble, passed, obviously, through granite soil to rocket and causing the wall of their carriage and the air inside it to vibrate.

— Yes, this is a fire-ball, — noted the Swede. It struck directly against granite surface of mountains, not losing its huge speed from atmospheric resistance and that is why it lit up like a little sun.

— Surely, a chunk of iron, being melted, being evaporated, and being smashed in pieces, gave this brilliant fireworks, — said Ivanov.

When they left the rocket and found the fire-ball, their assumptions were justified; they found at the place of impact many incandescent pieces of iron, smelted into the stony masses. Little fragments had cooled, and the travellers took several pieces for momentoes. Clusters of these did not differ in any way from known terrestrial aerolites.

43. Farewell, Moon! Departure from the Moon

Temperature continually increased, and the struggle with it was thoroughly difficult. This also impelled them to leave the Moon.

They selected an even place, part of a mountain rising at an angle of 10 - 20 degrees. On it they set the rocket, locked themselves in it and activated the firing apparatuses.

— Farewell, Moon! — exclaimed the Swede, looking out the window.

At first they were rolled along the mountain, then they left it and dashed into ethereal space around the Moon. They rose even higher and higher, obtained even more and more speed, until they attained a speed of 1600 meters per second. Then detonation was ceased. They rushed around Moon at a distance of 250 kilometers from its surface. Moving with such speed, they could make a full orbit in two hours. At first before them flashed unknown sites with unknown mountains and cirques, then they saw the half of the Moon with which, as scientists, they were well acquainted. They saw it as if in a telescope, bringing it a thousand times closer. But, indeed, picture of studied part of Moon was incomparably clearer than in the most unimpeachable reflector; terrestrial atmosphere did not hinder it and telescopic glass did not distort image. Moon was huge, occupied a third of the celestial circle (120°) and seemed concave, like a round cup. Rocket was as if in its center. Partly it reminded one of Earth on distance of thousand kilometers from its surface. There was, however, difference. The Moon seemed more dead, more monotonous, due to the absence of atmosphere, water, clouds, vegetation, and snows. Here a clear sea, a ridge of mountains, there cirques — pliny, Poseidon; here Swamp of Dreams; nearer — again mountain ranges; there cirques — Bessel, Menelaeus, Manil. Here already all this remained behind... Again there appear numberless cirques, craters, mountain ridges. Here the Caucasus, and after them the cirques Kolipp [?]. Here already and these were concealed... Under them spread numberless plateaus and depressions, called seas, in which there was, of course, less water than in the Sahara. Their edges are covered with cirques, ranges; everywhere are scattered cliffs, stone masses, craters of all dimensions, ravines and crack on all sides. All this was excellent and instructive, but it was impossible to lose time because of the lack of vital supplies. Furthermore, for them there was still a long road; they had to reach the orbit of the Moon and rejoin their comrades. When they flew above the known part of Moon, at the same time they saw the Earth. It had the form of a Moon, only with diameter of 2°, i.e., four times larger than the Sun. Form of Earth at a close distance was already described; far off it was the same, only on a decreased scale.

Thus, after circling for several hours around Moon, they again renewed detontion, attained a speed of about 2 1/2 kilometers per hour [sic], ceased detonation and dashed from the Moon on its terrestrial orbit. Moon became even smaller — it occupied 100°, 40, 20, 10, 5, and then was leveled with the Sun. Still long before this the speed of rocket was excessively small, and time was dear: therefore, they accelerated the motion by detonating. By their calculations, the large rocket with greenhouse should appear. Both travellers with agitation looked for it in the telescopes and did not find it... Desperation set in. They perceived the mirror polyhedron of the rocket, reflecting sunlight for thousands of kilometers. Its brightness they noted with enthusiasm. It shone at times and disappeared, then again appeared, etc. There were no more doubts — in some two thousand kilometers from them enjoy bliss their friends. They directed their way in the direction of the sparkling and vanishing star, and in three hours they saw the large rocket and the still larger greenhouse.

44. Again in the Great Rocket. Telegram to Earth About Moon

The reunion was joyful. Questions flew back and forth, but the returning travellers stated categorically that they needed rest and reinforcement after all the agitation experienced. After several hours Ivanov and Nordenshel'd gave a detailed account of their adventures, showed the collection of minerals and precious stones; the listeners were specially enthusiastic, when they saw the huge diamonds of wonderful game.

For Earth they drew up a telegram about the adventures on the Moon, with the following content. "We are fully safe and happy. We are on the lunar orbit in the diametrically opposite point, with respect to the Earth's satellite. Two from us succeeded in landing on the Moon, made a circumlunar journey, and gathered samples of lunar rocks. Due to shortage of vital supplies it was necessary to leave the Moon, not studying as much as we wanted this interesting world. However, this

information about it was obtained. The hemisphere of the Moon never visible from Earth does not essentially differ from the visible part, studied by your astronomers. Traces of atmosphere and water there hardly are noticeable there. The arch is hemispheric, not flattened, from above black, with an infinite number of unblinking stars. Day and night are 30 times longer than on Earth, which is why at night the cold reaches 250°, and by day the heat goes to 100° - 150°. Ordinary plants — rooted, motionless — are not found. But there is living world, varied enough. It represents the joining of the vegetable kingdom with the animal; it is possible to take them either for mobile plants, or for animals with chlorophyll in their skin, able to be nourished by inorganic food, like the majority of terrestrial plants... Moon is covered with infinite cracks of any dimensions, to width of canyons. Temperature in their depths is constant and in equatorial regions reaches to + 25° Celsius. In them the lunar animal-plants are concealed and are protected from heat and cold. All their motions are fast and adroit, since they frequently have to save themselves from persecution and devouring by bigger and stronger types. These latter ones do not all live in burrows, some run after the Sun and, thus, use the constant temperature most favorable for them. We did not manage to gather samples of the living world... We did not encounter on the way constructions of rational creatures — buildings, machines, bridges, and therefore think that living creatures standing as high as Man, are lacking there. Sun moves 30 times slower; to keep up with it is very easy, and it is also possible to force it to move to any side, to transform day into night and back, sunrise into sunset, and so forth. In general, all astronomical data are confirmed. For instance, Earth is visible only from the visible hemisphere of the Moon and has the form of the Moon, but with a diameter in 4 times greater. It always appears motionless, eternally standing on the horizon, at a certain altitude or at the zenith. But at the same time it makes small, noticeable monthly oscillations. They are more noticeable near the horizon. Earth enters into continuous motion only during the motion of man, [the

observer], although at a very small speed. It also can be forced in this way to move to all sides and in all manners... Speed of carriage or man to obtain the desired apparent motion of the Sun oscillates around 4 meters per second, or 14 kilometers per hour. Such a high speed not only is possible for the carriage, but also for a pedestrian, since weight on the Moon is six times less than on Earth, and resistance of air is lacking. There are no winds, certainly. On the unknown half of Moon the Earth is never visible; there the nights are wonderful, thanks to the countless numbers of polychromatic stars visible. The Earthlit nights on the Moon are so light that it is possible to read without difficulty. They also are wonderful, but only some time after sunset, when temperature is suitable for Man. Stars are visible both during sunlight and during earthlight but in different numbers; from craters, depressions, and ravines they appear much the same as at night. The Moon is a world, absolutely unsuitable for human life, owing to the huge difference of temperatures of day and night, reaching 400° C. Cultivation of plants, because of this, is absolutely impossible. This inorganic world is rich in minerals, precious stones, and unoxidized light metals and their alloys, which are found in the depths of ravines. Mountains, heights, and depressions consist of granite, syenite, basalt, trachytes, generally of volcanic types known on Earth. Here and there we saw thin drifts, as if formed from compressed dust. We found some heavy and precious metals, and diamond deposits in such abundance that Earth can fear a drop in the price of diamonds. But, then, beauties can hope to adorn themselves without constraint with precious stones, when constant communications are established with the Moon. No volcanic activity was noticed. Mountain cave-ins are common. Fire-balls, striking against the surface of the Moon, are in highest degree impressive, a mass of dazzling light and a whole shower of sparks. Contrasts of temperatures are huge, due to absence of equalizing action of water and air. The always-shaded depressions and pits are terribly cold. The temperature of similar places in northern and polar regions should be colder still. It is possible that extensive layers of hardened water and atmosphere have accumulated there. But this is not

actually confirmed. There is a dawn, depending on illumination of sites by light reflected repeatedly from the summits. That is why the shadows are not quite black, but are not so light, as on Earth. In other places, more frequently low ones, rather thick deposits are noticed, formed, probably, when the mass of the Moon still had not cooled, when temperature was more monotonous and when water gases still had not been liquefied and absorbed by soil, but flowed and destroyed granite, like on Earth."

45. Terrestrial Matters

This telegram on Earth was received enthusiastically; many mourned the fact that the Moon could not be inhabited by people, and the owners of precious stones became gloomy and constituted a conspiracy against reactive instruments. Poor beauties cunningly looked at the rich. In general, for people this first visit to a strange planet produced great enthusiasm, boldness, and hope. Nevertheless, the Moon may be useful for humanity...

The report about diamonds and precious stones produced sensation among the dandies of all countries. Prices of jewels noticeably dropped. A great number of rich people sank a significant part of their capital into the production reactive instruments, in the hope of trade in diamonds and other lunar goods.

Meanwhile new colonies, on distance 5 1/2 Earth radii, or 34 thousand kilometers from its surface, grew and were settled. Dwellings (greenhouses) of the described type were weeded by happy men, women, children. Already they lived a family life, — properly and thoroughly.

46. Pictures of Migration and Life in the Ethereal Colonies

For settlement of colonies there are chosen the best people: easy to live with, mild, resourceful, diligent, physically strong, not old and, as far as possible, not yet married. But the number chosen appeared excessively great, and

therefore, due to necessity, they gathered on Earth in hostels, lived together, studied one another and made from among their group a new selection. But again there was obtained a surplus, which now still could not be delivered outside the Earth. It was necessary to select for the third time. These were almost ideal men and women, angles in human form. However, these "angles" were subjected to very severe tests, before being sent into space. Thus, they were placed in a medium with the same quantity of oxygen, as on Earth at sea level, with the nitrogen removed. Then the quantity of oxygen was decreased by a fact of 2, so that it was no greater than on five-kilometer terrestrial mountains. Whoever, doing this test fell in a faint, became ill, weakened, lost appetite — they did not get into the colony. They had to feel fully normal on a diet of only fruits and vegetables. Thus, already during the first selections many "angles" were rejected. There were misfortunes. Once, by error, almost all the whole air was pumped out; but now, seemingly after 5 minutes, the error was corrected. All were found to be unconscious. Some of the injured managed to revive; other perished — in all three men died. Those reviving were, with great joy, equipped for the journey. If the same misfortune should happen to them in the colonies with breaking of the greenhouses, then they nevertheless could be saved. This was a great advantage. It was hoped, with the passage of time, to develop means of training people for such properties, so that they would not perish immediately in the absence of air. They would be almost fully safe in the outer space colonies.

The chosen and tested departed in crowded rockets crammed with people. Journey was accomplished in 10 - 15 minutes and therefore could not be tiresome. It was so fleeting that to talk about it is not worthwhile — the more so, because we already described it earlier. The passengers did not succeed to look back to realize their position, since the experienced escorts swiftly extracted them from the water and led them with known precautions into the greenhouse.

At first all this arriving company appeared in a common hall 1000 meters in length, 10 in width, and 5 in altitude. They were struck by the great bulk of the

site, the mass of greenery, the light penetrating through it in golden beams. There was something magic in the first time in this spectacle; the hall seemed infinitely long. All those arriving noticed only the green, the light, and the arched transparent ceiling. The newly arriving ones were absolutely lost, although their conductor encouraged them in all possible ways. Becoming acclimated, they began to notice far off some sort of spot; no a fly, not a butterfly, approaching even nearer and nearer, becoming even clearer and turning out to be old friends, who arrived earlier at the greenhouse. There erupted joyful exclamations and warm embraces. Those approaching had small wings on the sides of the body, like fishes' fins. They were actuated by the legs. The wings moved, like fins, and gave forward motion in gas media. They were easily donned and, like clothes, easily removed from the body.

They moved like birds or fish. Gravity here could be managed without wings, by pushing off with the hands from the air or any object, but the wings were more convenient and with the least effort gave significant speed and elegant motions...

— Mother, are these angles or devils? — shouted the children. — They will not drag us into hell?.. Know, then, that after all I deceived you... I consumed this pastry... You must not tell them...

Children covered their eyes, some cried and backed off... if this here was possible; but they only agitated powerless legs, imagining that they were running. Gradually the parents, themselves agitated, calmed the children, and the "angels" now obtained wings and attached them to the newly arrived. They were quickly taught to move them and to head where they wanted. This science was quite easy to master. Only at first there were heard desperate or dissatisfied exclamations.

— Oh. mother, I just can't fly there treat... and I cannot turn around! But the "angles" instructed and returned the lost souls.

— However, masha, this is not so easy — to fly! I was absolutely confused in this greenery and not able to disentangle myself...

They rescued these also...

— Alexander, what to do?.. I cannot turn to the right...

Alexander, already learning and alertly flying, helped his spouse.

— And I, mother, look how I fly. — screeched Olechka. — Here, look, I fly to the windows, here to the wall, here I return...

All were replete, none were allowed to go hungry, and therefore they were in an excellent mood, although they were a little taken aback. Transformation was so sudden that majority were as though in sleep.

— How warm! — shouted the children. — Before it was this warm very rarely... only in the hot summer.

All had long since removed their travelling clothes and were covered by light belts. The temperature was close to 30° C.

So conversed a family, strolling in the huge hall. Toward them strolled other families. Beams of the Sun, piercing the plants, illuminated with odd patterns these beautifully fluttering groups. The newly arrived did not disturb anything: for them was to look around, gradually to familiarize themselves with the surrounding life and new obligations.

What, in essence, did the colonists do? Really did they only stroll, eat, and sleep? It is true, to do that was almost fully possible. However, this was not the case.

While the population of greenhouse was small, 400 people, but it could shelter and feed up to a thousand. This dwelling was created for them by the Earth and partly on the Earth. Terrestrial builders, specially arriving here, assembled the greenhouse and constructed all the things necessary inside it for the growth of plants. Thus, the settlers fully used for nothing a gift of Earth, of the labor of their colleagues. They, as it were, obtained an award for their fine qualities, marking them favorably for selection on their native planet.

Could colonists now to construct similar greenhouse-dwellings for others or for themselves? For, now no, because the settlement of outer space had just now

began. Inhabitants are still few, and therefore mills, factories, and workshop for complicated production could not be built now. Furthermore, building materials still have not been found. To deliver them from Earth is too expensive. The Moon would be much easier, but that also would not pay. The scientist explores whom we left on the orbit of the Moon hoped to rescue the colonists in this respect and to set them up in such a manner that they always with surplus would obtain all and more of the necessary and varied resources right at the place of their habitations. Then will commence more many-sided activity and will not be always the need for the somewhat vexing help of Earth... And what here is the vexation? Does not the baby use the help of his parents and does not the infant, sucking at the body of the mother, draw from it vital juices? Who reproaches the weak!.. There will come for them the time of more intensive labor.

But the colonists are fully able to support order in their extensive house, to learn, to produce scientific investigations, to grow mentally, physically, and spiritually. It is impossible besides to manage without organization of society, and they have elective leadership. Every special hall has its own representative. They are elected by boys, girls, the ill, family people, old men, and old women. It was required to select 8 representatives. But since for one [person] it would be tiresome to give orders without rest, they elect from every corporation 3 - 4 men, who excute their general leadership; these also command in turn. The elections are repeated at the desire of the population, in order to change those poorly selected or too long in power. The electorates were given some sort of signs, so that any knew their own representative. Sign was in the form of dry fruit, flower, wreath from everlasting flowers or anything similar. Here there are, swaying by wings, like a swarm of bees, group of young men with their leader, adorned with large flowers... here a charming flock of children with their senior... here girls headed by a chosen one, distinguished by a beautiful wreath... There old men and women with their representatives... There family men, and there their wives with the little ones...

Remaining electorates fly in individual groups, like idlers until they are called to order for control or for other obligations. Old men have old leaders, since the young cannot penetrate into their spiritual state and grasp well their life, acts, and needs. Also the women are managed by women, since the female world is not in full measure accessible to the soul of man. For the same reason the children have their own representative; after all, adults in the same way frequently forget their children's weaknesses and needs, as old women forget their girlhood and motherhood.

Circle of electorates resolves matters concerning all the population without distinction of sex and age, — strictly speaking, not [the circle] but its next representative, sometimes a man, sometimes a woman. Thus, there is no delay in matters. If, however, in the group there are many dissatisfied orders of the electorate then it, of course, is changed. The electorate expresses the consensus of the collective, which is and it is selected. Also, and in every particular group, for instance, in the group of girls, the one chosen expresses the common will and therefore, will command and will issue particular laws, while it enjoys confidence. Dissatisfied persons will always be found, but unity of every group and all population requires such order. In the standing congress the colonists study one another, and this is important. Thanks to this there are accomplished successful elections, assignment of duties and work. Marriage and divorce are authorized by those elected from all the population. Conflicts within each corporation are resolved by the representatives of this corporation. Discords and arguments between members of various corporations are litigated by the general representative of all colony. It is true, there is nothing to divide them and nothing to argue about. Assignments on work are made also by the separate representatives; for instance, married women are assigned one or another post by their own representative. Work in the colony is such: 1) to watch over the temperature in the various places of greenhouse. The heating of areas varies according to their purposes, e.g., for location of newborn it is close to the temperature of human body, for the

old it is somewhat lower, for the young men — still lower; 2) to watch over the degree of humidity or dryness, for which there exist special instruments described by us; 3) to oversee the proper action of the pumps moistening the soil and delivering to it nutrient liquids and gases; 4) to care for the restrooms; 5) observation of plants; 6) observation of composition of atmosphere, and its pressure; 7) care of the integrity and condition of the shell of the greenhouse and the conservation of the gases enclosed in it.

Temperature of all parts of shell of greenhouse is so constant that there are no conditions for formation of cracks and leakage of gases. Draining gas will form on the outside a smoke puff, very noticeable. Furthermore, it closes on electrical current, which indicates the number and position of the damaged site. The duty officer easily finds it. First he putties the crack roughly, and then closes it thoroughly.

People are assigned work according to their abilities, desire, strength... Another duty is to see to the cleanliness in the greenhouse. From the plants there drop leaves, grafts, fruits, sometimes particles of the soil are spilled. These rushes into the air, but thanks to weak centrifugal force they are collected at the ends of the greenhouse, close to the restrooms, whence they go for transformation into fertilizer. All the waste products of people and plants are dissolved in a large quantity of water, which is directed by pumps into the soil pipes. There it is soaked up by the soil and the roots of plants, passes into the atmosphere through their leaves, and moistens the air. The latter, passing through external, refrigerating pipes, emits vapor, in the form of dew, gathering in abundant flows, carrying water clean, as rain, to the restrooms for baths, drinking, and so on.

All who wish can learn to read, write, do crafts, and study arts and sciences. He teaches who can find pupils and has the knowledge, wish, and ability to instruct. Such one freed from other duties by assignment of the leader. The system of studies depends on the character of the teacher and the students and on their desires.

Crafts and arts, with the small number of colonists, still not have large applications; therefore chiefly now the sciences are read. They have a large program: geometrical knowledge, mechanical, physical and chemical, cosmic knowledge or description of Universe; further — biological information, the past, present, and possible future of living creatures, sociological knowledge. They study philosophy and consider questions still not solved. All sciences, from beginning to end, are based on mathematical information.

47. Union of Colonies

To the first colony there quickly was joined another, a third, etc. After several years their number became very great. They are interconnected free passages, but with hermetically closed hatches, so that in case of damage to the shell of one or another greenhouse or its rupture by a fire-ball, gas will not depart simultaneously from many sections. Joining of the greenhouses decreases leakage of gases, enriches the life of the colonists and gives them larger enjoyment, since inhabitants of one can visit colonists of all other greenhouses. During passage of a connecting chamber the door is closed hermetically immediately after entering. But the passage is absolutely free, as if from one room to another, without double doors, pumping of air, etc. The doors can even be left open; they shut them tightly for the sake of precaution.

Several hundreds of colonies constitute a new, higher unit. Every colony gives several of its best people, leading in turn their population. Some of those chosen from every colony are selected to join with others like themselves. They constitute the population of a higher greenhouse with a government, similar to that described... But there all one more accomplished, above, stricter in moral relation.

These chosen ones, staying together, move out to govern the lower colonies, but old directions pass to their place. Thus are alternated the chosen persons, occupied now with governing, now with mutual study.

We did not describe as yet illnesses and deaths in colonies, since illness there had still not appeared, and so little time had passed that death had not succeeded in destroying anyone with his scythe. There was only a case of mild madness. One of the migrants believed himself dead and already on "that" world. They were in no way able to convince him. He was even more and more confused in logic... Then the leader, in hope of healing him, resolved to send him to Earth. They heard that he was cured; but by his own desire he remained on Earth.

We will now leave our colonies to be multiplied, to be organized, to prosper, to improve their life, composition, power, and will return to our scientists, left on a lunar orbit...

48. Among the Scientists on the Orbit of the Moon. First Conference

Many times flew our travellers around the Earth, moving level with Moon, before they resolved what to do further and what to start.

— The space between Earth and Moon, open to us for settling, — Newton started the meeting, — has one important deficiency: the absence of a sufficient quantity of materials for building and other public needs.

— Delivery of material from Earth, — confirmed Laplace, — is excessively dear.

— It is possible to deliver materials from the Moon, — noted Franklin. — This will cost 22 times less... But the Moon is inconvenient for settlements and works, as was clarified by Ivanov and Nordenshel'd during their stay there...

— I envision our leaving, in order to transfer the colony to the region of the small planets, huddling between orbits of Mars and Jupiter, — said Newton. — Only one excites certain doubts; temperature in this region is low. Maximum temperature, i.e., with a black surface and under the most favorable conditions, at the distance of Mars constitutes about 83° of heat. Mars is one and a half times further from the Sun than the Earth. This is still nothing. Even at double the

distance from the Sun the temperature is 27° of heat. But at the distance of Jupiter it constitutes already about 80° of cold. At the average distance between Mars and Jupiter it is close to 30° of cold...

— It is possible to increase it with the help of mirrors, — noted Ivanov.

— This applies to us for our journeys, but not for colonists, where one must look for simpler solutions. We, certainly, will not suffer cold, thanks to our devices, even at the distance of Saturn...

— For colonists, thus, — confirmed Franklin, — the most convenient of all would be to settle in a belt close to Mars. There, beyond it at a doubled distance from the Sun as compared with Earth, the highest temperature is 27° of heat...

— And is it not better for them to construct settlements between Earth and Mars, or nearer to the Sun — between the orbits of Earth and Venus? — asked Laplace.

— Both the one and the other one probable and fine, if only in these regions we found matter in the form of significant fire-balls or asteroids several hundreds of meters in diameter, — said Newton.

— One huge asteroid already has been found between Earth and Mars, — noted Ivanov.

— This is Eros, — said Newton. — True, due to the eccentricity of its orbit, it sometimes departs from the Sun further than Mars. It is possible to use its mass. But after all this is such great bulk!... In general, a planet less than 10 kilometers in diameter cannot be seen from Earth by the best telescopes and under the most favorable conditions in belt of planetoids. Consequently, asteroids less than 10 kilometers in diameter, be there millions of them, still cannot be discovered by Man.

— And they must exist, — he continued. — Really, go into a field: of what stones will you notice more — big or small? Certainly, small, since the smaller they are, the bigger their number. We should find the very same thing in

the infinite spaces of the Universe. Actually, big planets in all number 8, if one were to ignore satellites. Little planets, or asteroids, number about 700; fire-balls and aerolites are infinite in number, judging by the abundance of shooting stars. This means that planets less 10 kilometers in diameter should number much more than 700 in our solar system. If we do not see them, this does not mean that they do not exist. We also would not see fire-balls, if they did not entangle themselves in our atmosphere. We would not see large asteroids if it were not for telescopes and the sensitivity of photographic plates...

— Therefore, it is possible to hope — said Laplace, — that we will encounter a great number of small planets nearer or further than the orbit of Earth.

— Thus, gentlemen, — said Newton, — we first of all will direct our celestial way there, i.e., to the terrestrial orbit...

The conference fully agreed with this.

49. Second Conference

The following conference was also dedicated to the proposed journey.

— We already are almost free from the attraction of the Earth, — said Newton, — since here the force of its gravitation is 3600 times less than at the surface of Earth. Now we pass in every second about one kilometer around it. If this speed attains one and a half kilometers, then we will depart forever from the globe...

— But with this we will retain the speed with which the Earth is revolving around the Sun, — noted Laplace. — This speed we obtained from Earth when we were still on it, and could not lose it. Thanks to it we will not fall into our luminary, but we will move around it, similar to the Earth.

— This means an additional speed is needed for our rocket and greenhouse not exceeding half a kilometer per second... This such a trifle! — added Ivanov. — The consumption explosive will be almost inconspicuous...

— Then, in order not to collide with Earth while moving along the same orbit with her, we will renew detonating and will be then, judging by its direction, moving away from the Sun along a spiral or approaching it along one or another curve, which depends fully on us... — pronounced Franklin.

— Consumption of explosive material again will be very insignificant, — noted Newton. — But how to go? We still have not solved the question, of whether to approach the Sun or to depart from it...

— It seems to me, — said Ivanov, — that it would be better to move outward, since temperature here is excessive, but we can bring it without mirrors to 150° C. and, mainly, we will have more chances to encounter on the way to Eros, Mars, and the planetoids significant little planets, at least many that are less than 10 kilometers in diameter.

Thus, they decided, dispatching a phototelegram to Earth: "Are safe. Think to head at first along ecliptic, but then somewhat further from Sun, in hope of finding masses sufficient for buildings of colonies between orbits of Earth and Mars. Greetings to Galileo. Helmholtz and our other comrades in the Himalayan fastnesses. Newton." A return telegram with wishes of success was received.

50. Around the Sun, Beyond the Orbit of Earth

They used the weakest detonating. Attraction of Moon could be absolutely disregarded, the more so, because its mass is 80 times less than the mass of Earth. Relative weight appeared, but in such small stress that it was almost unnoticeable. However, the visible dimensions of the Earth and Moon noticeably decreased. After ten Earth days the angular diameter of the Earth decreased twice, as did that of the Moon.

— Now we have a speed, — said Ivanov, — which absolutely liberates us from the attraction of the Earth and its satellite...

The Earth grew even smaller and resembled even faster a bright star, rather

than on a planet. Phases of Earth and Moon became inconspicuous without a telescope. They were identical: if Earth was in the quarter, so was the Moon also. Detonating was not ceased and acted in the direction of their true motion around the Sun. Gradually they moved away from the ecliptic, or terrestrial path. Earth became no brighter than Venus; near it they saw a very weak little star — the Moon.

The position of our travellers was not at all changed, if one were to ignore the apparent and gradual transformation of the two large moons, i.e., the Earth and Moon, into stars, and the hardly noticeable decrease in the diameter of the Sun.

Owing to this the temperature dropped very slowly and still insignificantly. But by increasing the black surface of the rocket turned to the Sun, its temperature was made deliberately higher, so that for those traveling there was not the least doubt of the possibility of changing it in either direction in very wide limits. As we know, even near Mars it can be brought to + 83° C. Greenhouse humbly followed them and delivered to them all they needed. Their placidity was not at all disturbed. They ate, slept, worked, as tranquilly as earlier, when they still were not separated from Earth. They sometimes went out of the rocket into ethereal space, donning pressure suits. The sky, as before, was black as ink. On the one hand shone the Sun, on the other — a great number of lifeless but polychromatic stars. Pattern of constellations was not at all changed. The Milky Way, as before, divided the celestial sphere into two halves; the stars in it were extremely numerous and the fog was much less... As before there were visible vagrant stars, i.e., planets. Big asteroids were visible without a telescope and were distinguished by their motion among the "motionless" stars. "Lunar" nights, of course, no longer existed. Detonating force pushed the rocket in the direction of its motion and therefore should have accelerated it, but the matter was reversed; motion was delayed as the rocket moved away from the Sun. This was like the motion of sleighs running uphill; although the horse pulls them, the speed nevertheless decreases.

51. On an Unknown Planet

They looked for fire-balls and asteroids, vigilantly looking in telescopes and simply observing from all windows on all sides. On the tenth month of the journey, when already the crew were homesick and fatigued, Franklin saw a huge mass quite close to them and almost motionless. It was clear that this was a planetoid, proceeding, like they were, around the Sun.

But since the rocket was still under the influence of pressure of exploding gases, this agreement of motions was quickly disturbed, and the mass began to move away from the rocket. They interrupted the detonating and again renewed it, directing the rocket to the asteroid. The travellers set themselves at the windows and did not lower their eyes from the great bulk. Its visible dimensions continually increased and occupied almost half the sky. But the mass was very irregular, prolongated and angular. Here and there it shone brightly, reflecting the beams of the Sun. Curiosity conquered the spectators.

Finally they used counterdetonating, in order to reduce speed so as not to bump against the planetoid. Here they quite stopped. It was necessary again to use the combustion tubes and to cease their action. They were at a distance of several tens of meters and almost in relative rest.

— Enough. — said Newton. — Let someone attach the rocket to this planet...

Ivanov long since had donned a pressure suit, trusting to depart first. He went out, drawing after himself a chain which was connected to the rocket. Evenly moving to the planet, he softly bumped against its stone heap. There was nothing with which to attach the chain; it was a round granite and metal stronghold. Ivanov thought to use a strong magnet, when he touched chunks of iron. But that also turned out to be superfluous: the rocket, in virtue of gravitation, actual gradually began to approach the planet. In order to avoid even a very weak impact, which could damage greenhouse, it was necessary before the actual contact, again to

activate the pressure of the exploding gases. After several hardly noticeable jumps the rocket and greenhouse adhered to the planet and no longer were separated from it. All the inhabitants departed from the rocket, dressed in pressure suits, since there was not the least traces of an atmosphere.

On the planet it was possible to stand, to lie, to sit, as on Earth. But the gravity was so slight that the least, even minute motion removed a man from its surface to several tens of meters in altitude.

Laplace took from the planet a stone, attached a string to it, held the other end in his hand, like a pendulum. The stone began to swing — but, good Lord, how slowly! There was not enough patience to count its oscillations and to observe the time... Nevertheless, they carried out this test... The pendulum, one meter in length, made one oscillation in 80 seconds.

— Hence it may be concluded, — said Franklin, — that the attractive force of this planet at this point, is 6000 times weaker than on Earth. In the first second here a body falls somewhat less than one millimeter. I weigh here, as do you, 6000 times less than on Earth, and I have, hence about 13 grams of weight!

Around them they observed strange irregularities in the outlines of the horizon. It would be difficult to see on Earth, even in the most fantastic mountains, such a picture... The whole planet was some capricious fragment... Under their feet were stone masses with a great number of impregnations of metallic alloys or pure metals: some that darkish, like old iron, some brilliant, like silver or nickel, others yellow, like brass or calcium, or reddish, like copper and gold... They were drawn now to that, and to other, and to a third. But to move was possible only quite slowly, and since the travellers were bursting with impatience, any energetic motion raised them in space and removed them upwards at a huge distance from the planet. Before they returned to it, they were respectably scared, imagining that they had lost the planet forever. Those who had the little pocket explosive missiles started them needlessly and hastily returned to the planet, but not all had

them. The others flew upwards for 10 minutes and more and returned for almost half an hour. What was it to them, when they so hungered to investigate the planetoid... They moved off 250 meters — here will vanish any! They adapted, of course, they had been formerly in such conditions... Then they thought to move very simple and fast enough — up to 4 kilometers per hour. For that it was necessary to push off (from stones and vertical flanges) in a horizontal direction. But if one were to shove excessively strongly, then it was possible to fly quite away from the planet and to be lost in the infinite free space of the solar system; those gone astray could be saved only by pocket explosive devices or by those people who had one and therefore, can catch their comrade and bring him back.

Thus, by this simple method our wanderers flew all over the planet and found a great number of metals and their alloys in pure form. The sparkling part of the planet seen from afar turned out to be heaps of gold, silver, and nickel. Here were precious metals in thousand of times greater quantities than all the inhabitants of the globe possess...

Gravity and its direction in various parts of the planet were extremely varied, due to its strange form. At the sight of treasures each expressed in his own way his astonishment and enthusiasm... They showed this in poses, but faces and their mimicry were not easily seen; to talk was possible only by converging and touching helmets, and they, drawn by inquisitiveness, scattered helter-skelter. They took photographers, gathered collections of minerals and metals, prepared materials for determination of dimensions and mass of asteroid and returned, enriched, but not burdened, to the rocket. Yes, and it would be difficult here to be burdened. Burdening set in only if one attempted to carry a mass of 600 tons!... And that weighed (terrestrial) only 100 kilograms.

52. Again in the Rocket. They Fly to Mars

Again they actuated detonating and again began to move away from the Sun, investigating the space from Earth to Mars. The unknown planet which they had just left quickly disappeared from view, as if actually moving away from them. But it

continued to occupy the scientists no less than when they could see it; they sorted and studied the stones, metals, and alloys captured from it. Gold, silver, and platinum were the most natural, with insignificant quantity of outside metals. Average dimension of the planet was calculated as 900 meters. No wonder, therefore, that terrestrial astronomers do not know of it. At such a distance it is impossible to note. After all, the satellites of Mars, with diameters 10 times larger and with area one hundred times more extensive, were found with difficulty. The volume of the unknown planet was close to 360 million meters; its mass could not be exactly determined, but, judging by the abundance of heavy metals even on the surface, the mass was not less than 7,200 million tons, if one were to take the average density of the planet as 10. It rotated weakly.

— Here is material, — said the Russian, — which is enough to construct comfortable greenhouse-dwellings for all humanity.

— After all, for this there will be necessary about a ton per man! Is there enough? — objected Newton.

— If not, — then it is possible to add to it by detecting other similar celestial bodies. Space even to Mars still has not been travelled. On the way to it we may encounter still thousands of such tiny planets...

— Very probably, — said Newton.

And indeed, during their spiral departure from the Sun they began to encounter asteroids almost every month; some were larger than the one described, but more frequently they had smaller dimensions. Few of them were investigated, but in those explored they rarely failed to find heavy and precious metals...

— Strange, — noted Nordenshel'd. — On Earth we find so little gold and platinum, but here the streets are, as it were, paved with them...

— Yes, this surprising, — confirmed Newton. — However, from the point of view of one hypothesis it is explicable. Very possibly, — he continued, — that these comparatively small masses are only parts or fragments of a large planet.

As fragments, some of them can contain internal, and others external elements of the whole planet. But the central parts of a planet should consist of the most dense substances, like, for instance, gold, platinum, iridium, and their alloys. This actually what we found in the planets we discovered. On certain of them, after all, we quite failed to find heavy metals; this means that such little planets constituted external parts of a great planet...

— Such an hypothesis is given Olbers to explain the formation of the great number of asteroids between the orbits of Mars and Jupiter, — noted Laplace. — Judging by our discoveries, it may be applicable also for the formation of celestial bodies between Earth and Mars.

— I don't understand, — asked one of the listeners, — what could have caused the breaking of a great planet into many small ones?

— Yes, this not clear. — said Ivanov. — Maybe, chemical processes inside the planet formed gases, whose expansion tore the planet apart, like a bomb; maybe, a collision of planets did this; and maybe, centrifugal force, continuously growing with the compression of the revolving planet played a role.

— The last alone could only produce separation of satellites and rings from the mass, but not at which we see, — noted Newton.

— Yes, probably, I agree with you, — said the Russian. — Possibly there acted a combination of these and other unknown causes, — he added, musing.

— But from your speeches there can be made interesting conclusions, — noted Franklin. — First, our Earth also at sometime can tear into pieces, and secondly, — the central regions of our planet should contain precious metals in abundance.

— We cannot now negate either the one or the other, — many voices sounded in answer.

— And if this is so, — said Ivanov, then it would be well if humanity, not waiting for a possible catastrophe, moved into the other world — at least into

these ethereal deserts, which contain all the materials necessary for safe arrangement here of man.

53. They Encounter Gas Rings on the Way

Every orbit around the Sun required more than a year and opened to them new worlds. Several times they came upon gas rings, — very transparent, rarefied, hardly noticeable, but with thicknesses of several kilometers. They appeared at first in the form of a thin, foggy line, pointed on the ends. When the rocket flew into one, there was heard a strange noise and the temperature in the rocket was somewhat increased. Its speed differed somewhat from the speed of these rings, but rocket, departing from the Sun, passed through them fast and they were lost from view. A great number of these rings, like planets, of course, were passed by unnoticed... They gathered gases of one of the rings. condensed them with pumps, produced on analysis and found oxygen, nitrogen, compounds of carbon, and traces of hydrogen and other gases.

This is delightful! — said Ivanov after first find. — In such ring it would be good to settle a colony: first, close by there will be gases; secondly, even if they should drain from a rocket, they would not leak out entirely, and will remain in the surrounding atmosphere, from which they can easily be extracted back. This discovery shows that the expansion of gases is not infinite, as indicated according to the law of boyle — Mathews, but something limits it.

— The conclusion is not new, — noted Laplace, — in our own atmosphere the same thing appears.

— There the infinite expansion of gases is limited by the attraction of Earth and molecular theory, — began Franklin.

— And here the same, i.e., attraction of the gas ring itself and maybe something else, — noted Newton.

— But what, what.? — exclaimed Franklin with impatience. — Attraction of the ring is insufficient...

— I do not know, — said Newton. — However, possibly the gases are spread over all the planetary system, although in small quantity. Thus thought, for instance, Mendeleyev.

54. They Approach Mars

Year passed after year; Mars already was near. The space between two neighboring orbits was so much studied that it would have been possible to send a telegram to Earth about the results of investigation, but it would have demanded a flat mirror 100 meters in diameter, and its construction now was not very practical. It would be simpler to return to Earth or to send a telegram from the orbit of the Moon or from anywhere still nearer.

Near Mars the orbit of the rocket around the Sun was somewhat less than two years. Boredom and depression accumulated sizeably; all wanted to be on Earth. They would return to it, of course, not along a spiral, but by shorter path. It would be possible to reach Earth in about four months. Mars was already at a distance of 10 million kilometers and had the form of a round little Moon with a diameter of 4 minute, i.e., it appeared 7 times less than our Moon, as it appears from Earth. In the telescope its "canals" and "seas" were splendidly visible; it is unknown with what the seas are filled, or from what the mountains, valleys, polar "ices" and "snow", are composed.

— Nearer to Mars we will not fly, — noted Newton. — A descent to the planet is extremely risky; we all are fatigued and, mainly, must as soon as possible notify Earth of our important discoveries...

Some protested, but others were glad that they would see their native land sooner.

— Mars will not go away... In a second expedition we will reach it, — noted Ivanov.

55. Is It Possible to Visit the Planets?

There was very much free time. Scientists conversed a great deal about plans for journeys, but more about Earth, its inhabitants and affairs, which they saw now in a rosy light.

We are more interested to know the judgement of the scientists about plans for further journeys and conditions of life in other worlds. Here are their conversations on this subject.

— We descended absolutely safely on the Moon; we live very excellently here, at almost the same distance from the Sun as is Mars. And how are things? The heat is as before, fruits grow slower, but are fully sufficient for subsistence, and if there is too little then is it impossible to construct two, even three greenhouses? — so protested and bubbled a very young and zealous member of the expedition.

— There are difficulties, — began Newton, turning to the whole meeting. — And to conquer them, it is necessary to toil a great deal on Earth, — both with the brain, so also with the hands. We will clarify the obstacles which prevent us now from descending on a planet, — besides our fatigue and the general desire to live and breathe on our native planet...

The group calmed, prepared to listen attentively.

— We will start with temperatures, — continued Newton. — We will imagine ourselves blackened by a sooty surface, perpendicular to the solar beams. It absorbs almost all the beams falling on it. The other, reverse, side should not lose heat. If, for instance, it is covered by polished silver, then this almost will be realized. Such a plate in ethereal space loses heat of proportionally to the fourth power of its absolute temperature. This is the law of Stefan and Wien, on which we will lean during further conclusions. How probable it is, can be seen from the resultant effects. Constants of this law, determined experimentally, make

it possible to resolve a great number of problems interesting to us. Here are my personal calculations. Temperature of surface of parts of the Sun will constitute about 6 1/2 thousand degrees Celsius. I give [you] ordinary temperatures; absolute [temperature] starts at 273° below zero Celsius. Absolute zero, by the known hypothesis, starts from real absence of heat in a body. Temperature of the indicated black plate, at the distance of Earth, can attain 152° of heat. This is the limiting highest temperature which can be obtained on Earth, the Moon, and on bodies located in ethereal space at the same distance from the Sun as our planet. This is also the maximum temperature of greenhouses and rockets of our new colonies near the Earth. It is sufficient to fry meat. But I will not talk about other methods, — for instance, the use of mirrors, — to increase this temperature. We will give here again the maximum temperature (Celsius), but at various distances from the Sun, taking the distance to Earth as unity:

Distance from the Sun.........	1	2	3	4	5	9	16	25	36
Temperature, Celsius.........	+152	+27	-27	-61	-83	-131	-167	-188	-202
Distance from the Sun.........	Infinite	1/2	1/3	1/4	1/9	1/16	1/25	1/36	0
Temperature, Celsius.........	-273	+322	+450	+577	+1002	+1427	+1852	+2277	+6427

— From this table it is clear that the extreme upper limit of our journeys in rocket is twice the distance from the Sun, i.e., about 150 million kilometers from the orbit of the Earth or 175 million from orbit of Mars to Jupiter.

— But allow me, — objected Laplace, — can we not use, to increase the temperature in the rocket and the greenhouse, a mirror — plane, cylindrical, or spherical?

— We can, — answered Newton. — Especially here, where there is no relative gravity and where the mirror can easily be made very thin. On planets we would encounter difficulties.

— But there is still [another] means to increase temperature of greenhouses: namely, if their glass will freely pass light and, in general, beams of high refractivity and will not release dark, thermal beams of low refractivity...

— Absolutely true, my dear Franklin, — answered Newton. — Then beams of Sun will enter in greenhouse, be transformed there in dark [ones] and remain in the greenhouse, by which the temperature will be increased more significantly than our calculations. But exact data on the degree of increase of temperature I now do not have. Again for study and references it will be necessary to turn to Earth, but for now it is more suitable to postpone this question...

— One way or another, — concluded Ivanov, — with the help of mirrors or by other methods, journey beyond Mars, perhaps, in time will continue to Jupiter and even further...

— I have no quarrel with this — answered Newton. — But here allow me to offer you a table of the highest temperatures for the various planets:

Planets	Distance from Sun	Temperature on Celsius
Mercury..........	0.39	+407
Venus............	0.72	+227
Earth............	1.00	+153
Mars.............	1.53	+ 83
Jupiter..........	5.20	- 83
Saturn...........	9.54	-134
Uranus...........	19.18	-176
Neptune..........	30.05	-195

— Hence it is clear that maximum temperature of the inner planets ("lower") is excessively great, but for a traveling rocket this is profitable in a technical connection, — said Newton.

— In a technical sense? — noted one of the listeners. — But will not the temperature be too high?

— Do not forget, — objected Newton, — that in the table there is given the highest ideal degree of heat hardly realizable in practice, — such as, for Earth, + 153°. Imagine the same plate, normal to beams and also polished on the rear side, but covered from the front part not by soot, but by a surface more able to reflect and to disperse incident beams of light. Then the temperature will be lower. It will be lower than zero; can even reach 273° of cold, or absolute zero, if all the beams of the Sun falling on it are reflected, while the other side, being covered by soot, will allow all beams to disperse in ethereal space. This conclusion is correct for every such plate. Without a doubt, this is only partly realizable, but still it indicates the possibility of the achievement of the nearest planets — Mercury and Venus — and even a still closer approach of a rocket to the Sun. If we were not so fatigued, then we could go to there now in full safety. In order not to burn up, we then would only need to expose the black part of the rear surface of the rocket and to close the front, transparent, part with silver-plated shutters. We could even, if we wanted, freeze in our rocket at the Sun itself or, at least, very close to it.

— Amazing! — the listeners were delighted.

— Thus, — concluded Ivanov, — journies in a rocket nearer to the Sun and further from it are ensured absolutely in a theoretical sense...

— Yes. — said Newton. — But this conclusion does not hold during descent onto a planet. Again we will talk first of all about temperature. Imagine an insulated black ball in ethereal space, i.e., with a certain similarity to a planet. It loses 4 times more heat than our bilateral disk; therefore its average temperature will be 1.4 times lower (root of the fourth power from four). Thus, we find for the various planets the following mean temperature Celsius: Mercury, +200°; Venus, +90°; Earth, +27°; Mars, -23°; Jupiter, -138°; Saturn, -174°; Uranus, -204°;

Neptune, -218°. In fact, the average temperature of the Earth is not +27°; and it is only about 14 or 15°. How do we explain this? The fact is that not all the rays of the Sun are absorbed by a planet; some part of them is dispersed by clouds, water, snows, sands, mountains, — in general, by soil of one or another property. On the basis of the indicated deviation of temperatures it is possible to calculate that the Earth receives about 80% beams of Suns; the remaining 20% are dispersed and reflected into celestial space. If the other planets, like Earth, rejected a fifth of the rays, then the temperatures of the planets obtained would be such: Mercury, +176°; Venus, +72°; Earth, +14°; Mars, -35°; Jupiter, -145°; Saturn, -179°; Uranus, -207°; Neptune, -221°. The average temperature of the asteroids falls between -35° and -145°. It is difficult therefore, to assume that Mars with an average temperature of 35° of cold, could maintain in its canals and seas liquid water. After all, its temperature is a whole 49° lower than the average temperature of the Earth. Even on Earth, a considerable portion of the surface is covered eternally by ice, by snow with frozen earth. Certainly, the condition of the soil and atmosphere for Mars will be different. If we consider them identical, then on the equator of Mars we would find an average temperature 49° lower than that on the terrestrial equator, i.e., not less than 25° of cold. What sort of water could there be?

— Well, but the mirror! Could not they save us from this icing cold? — the young listener objected despondently.

— They could, of course, — noted Newton. — Especially if there was no atmosphere. Its motion at its low temperature produces cooling with which it would be difficult to struggle. I, however, do not negate the possibility of successful struggle with special devices, not now available to us. Even on Jupiter, where the temperature attains 145° of cold, — a successful struggle with cold is still possible. But how will one struggle with the heat of the atmosphere of Venus and Mercury, where it reaches 72° and 176° of heat? On the poles, of course, it is

lower, but the murderous heat will be carried there by liquid and gas flows, i.e., by the local oceans and the atmosphere. Yes, and what gases will surround us during our descent to a strange planet?. Pressure suits and abundant reserve of oxygen can save us from the poisonous gases of the atmosphere, but no one can guarantee that the suit itself, and then our bodies will not be ignited by Bengal light... I negate nothing. All is possible, — cheerfully said Newton, — but it requires preparation, long and difficult work, if you want to triumph over hostile nature... Otherwise she will crush you and will not even notice it...

56. In the Direction to Earth — by the Short Route

It was unanimously resolved to head to their native planet. Mars, by its attraction, even more and more distorted the correct motion of the rocket. Since they faced a journey of about four months, the greenhouse could not be dissassembled; their reserve of fruits would not suffice for such a prolonged time. With it under tow, it was impossible strongly to brake the motion of rocket by detonating without damaging the living source of supplies. Nevertheless, braking was ten times stronger than during the slow spiral departure from the Sun. Due to this our scientists descended very steeply toward the Sun; the spiral was shortened. Now the greenhouse was not behind the rocket, but ahead. At the beginning of deceleration they were 65 million kilometers from the orbit of Earth and moved with a speed of about 25 kilometers per second. The speed was only 5 kilometers less than terrestrial. Due to braking it should have been reduced; but the plunge of the rocket, approaching the Sun, its descent — to the contrary, increased this speed. At arrival at the orbit of the Earth it had to be about 30 kilometers, i.e., to be even with the speed of the Earth; then, with the approach, to it [Earth], of the planet would appear even greater and greater. The increased speed once more would have to be braked by detonating. The thoughts of the travellers were full of the Earth and, therefore, are not as interesting to us, as were also the conversations which occupied them during the return.

The older ones became grizzled; the young were strenghthened.

Only the most necessary observations were made. They were overcome with apathy. They watched after the greenhouse, after the proper operation of it and the rocket. They went by such a short path that they hardly noted 3 or 4 new asteroids. The difference of their speed and that of the rocket was huge and to make contact with them for their investigation was difficult. Frequent looks were turned to a beautiful star, like Venus. This was Earth. They thought about it. It became even brighter and more excellent as they approached it. Now already it was turned into a beautiful, tiny moonlet. Its crescent increased, became larger than the Sun, still larger... They crossed the orbit of the Moon. Now Earth is huge, four times greater than its satellite, 16 times brighter. Their native planet grows; it has well the form well known to them. Now already Earth occupies 3, 4, 5 degrees in the sky; to it there remained a few days journey. Hearts pound disturbedly. Especially for the young. What will each encounter on Earth?

They decided to send a phototelegram on the small mirror. Ivanov telegraphed the following. "We, explorers of outer space, are near the Earth. We visited and as far as possible studied the space between the orbits of Earth and Mars. In it we found more than a hundred tiny planets with diameters of 5000 meters and less. But this is only a small part of that which we report... We did not encounter Eros. The asteroids we found present rich and inexhaustible material for construction of colonies beyond the orbit of Earth. Many of the planetoids contain heavy metals in ores and in pure form. Some 10% consist of 10% gold and platinum. We were convinced, judging by composition of these celestial bodies, that they constitute fragments of one or several large planets. The space we explored receives two and a half billion times more radiant energy than Earth. The free space in it is trillions times more than the terrestrial... Here and there we encountered gas rings. We carry samples of rocks, metals, and gases. No one was injured, we suffered no hardships. Life in the indicated limitless space is excellent: eternal day, eternal heat, wonderful, various fruits, and excellent conditions for the most

manifold technical and scientific activities. We should descend in the Indian Ocean, near the shores of East India. Warn the steamers...

Spare our modesty. No greetings and celebrations! God gave us talents, which we shared with the people, and that is all... We are in need of nothing. We all have had plenty, even honors. It would be better to support the geniuses in your midst, whom you hardly know, but who are more than you think. Try to discover them. Their hands are tied by their severe material conditions. "Ivanov."

Greenhouse had to be either dissassembled or left to circle along an elliptical orbit around Earth. Time was short, and therefore they resolved to sacrifice it. They also removed the planets in the rocket and the various delicate attachments for them; they were doomed to the same fate. A significant quantity of explosive was dumped, and lightening the rocket.

Decelerating grew continually stronger. Earth seemed huge and occupied a fourth of the sky. Colonies had been passed long ago. They filled the reservoirs with water and the scientists one after another were placed in them, so as to avoid suffering from intensive gravity. In short, they did all that had been done previously upon departure from Earth. The rocket and its parts functioned in just exactly the same way, — like a phonograph which, when activiated, plays one, and no other, song. Its action, nevertheless, was regulated by the handles of instruments, also placed in liquid...

The rocket enters in atmosphere; the thin safety shell is incandesced, but the speed of the rocket is no longer so great and drops still more as it approaches the surface of the ocean.

57. On Earth

More energetic braking, and the rocket has almost stopped... A light slap on the water, and the missile floats like a torpedo-boat.

Shutters, windows, are opened; the air of their native planet penetrates with whistle into the rocket. The travellers are as if in a dream. For a long time

they cannot collect themselves. After a long time they emerged from the tanks of safety liquid and dressed. But Earth is as if strange. It produces on them a stunning impression, not fascination, not terror. First of all it seems coldish and it is damp; then — legs, arms, and the whole body feels exactly as if poured from lead... For a long time they could not arise from the floor; their heads spun, they wallowed like drunks — especially the older ones. Air, burdened with nitrogen, seemed smothering, while the sounds of voices, owing to the comparatively dense atmosphere, seemed deafening. A motor cutter came and took them on a tug to a steamer... The travellers recovered somewhat. The wind refreshed them.

They had been forewarned about the modesty of the scientists, and therefore, no one disturbed them with questions. Actually, they did not feel quite well. They began sneezing... By the next day many found themselves with head colds. Some were ill with influenza. The mood of the sick ones was low; the joy of returning to Earth was darkened. It seemed that the Sun had no heat, that it shone sluggishly. Sky seemed excessively foggy; stars at night seemed far away, few and weak, especially near the horizon; the dome seemed —flattened from above... Everywhere there were unpleasant smells. Food seemed tasteless, people were awkward in their clothes, the furniture was disgusting, the weight unbearable, mattresses and pads rock hard. Newly arrived fell and stumbled about. Dozing, they pushed off, thinking to fly, but only shamefully and comically tumbled down; their discomfiture amused these around them. Most people did not understand, what the problem was, and they looked with surprise on these strange tourists. They were delivered safely to Bombay, from there further by railroad and, at last, on an air ship, to their Himalayan Castle.

Its inhabitants, of course, were informed about the adventures of their friends no less than others. They greeted them with prolonged embraces, but were very surprised by their bruises and the plasters on their faces. When the matter was explained, they could not restrain themselves from Homeric laughter, in spite of all efforts.

On mountains, although it was, for the new arrivals, unusually cold, the Sun felt hotter. Gradually they discarded their fur coats, recovered; the patches disappeared from noses and foreheads. They became accustomed to terrestrial life and even began to relish it. Helmholtz and Galileo did not leave them.

58. Meeting in the Castle. Plans for New Celestial Excursions

The whole world awaited the report of the scientists about their unusual and fruitful journey. Newton designated the day, when he with his own friends would read in the report in the castle.

On this day scientist delegates from all countries arrived at the castle.

Newton, interrupted frequently by his own [friends] no less than by the scientist followers and listeners, described in detail their adventures in space. Then he passed to practical conclusions and to plan for future journeys and explorations.

— The space at 34 thousand kilometers from Earth's surface, — said he, — there colonies are now organized, — is inconvenient, since there sufficient materials for work are lacking. Therefore, I propose that new settlements gradually be shifted into the space between the orbits of Earth and Mars. It has an abundance of very rich building material... I speak of very small planets, invisible from Earth... When the number of colonies has grown sufficiently, then they will develop their own industry; they will begin actually to construct their own dwellings and will not need the support of Earth. Material exists in the form of insignificant fireballs also and between Earth and the Moon, where the present colonies are located, but it is so scarce that it is not worth discussing. Only explosives and rockets, as means of sending people out, for some time still will be made on Earth. But rocket, upon fulfilling its assignment, can be turned around and loaded with explosives already prepared "out there." Then many of our descendants will find in celestial space asylum, happiness, and full moral satisfaction. Can we predict the human genius that will exist with these settlements beyond the orbit of Earth after

a thousand, a million years? Will someone reveal to us in advance, how the colonists will be organized materially and also socially with the increase in the number of new settlers? Can we predict what successes they will attain, as their industry and science is developed, how humanity itself will be changed there?... How through thousands of millions of years the radiance of Sun will weaken? Will we recognize what the inhabitants of sky will do then? Will they find an escape? Will they not depart for other, still living suns? What will the journey be like? What sort of planets will they encounter, and what will they find on them? After all planets, suitable for life, similar to Earth, are of infinite number...

— But this so never-never, so conjectural, — noted one of the scientist listeners. — Is the report as to whether it is possible to start in the near future?

— Now we will rest, recover from our strong impressions, collect our energy, — responded Laplace, — and we will equip a new expedition.

— Then, — said Newton, — we will head for the region of known asteroids between the orbits of Mars and Jupiter. There we should find much of interest. Incidentally we will make several orbits around Mars, and maybe even visit it. It will be easy to stop on its small satellites — just as easy, as to master the soil of the asteroids, thanks to the small weight on their surface.

— If we are not then overtired, — said Ivanov, — then perhaps, we will reach Jupiter and Saturn. We could hardly manage to land on these planets, since daredevil invite almost certain destruction. But it is possible to circle near them at a short distance; to visit their small satellites and to fly along the rings of Saturn...

— Possibly, we will sooner start a journey in the direction of the inner planets, Venus and Mercury, — noted Newton. — It is difficult to expect beforehand how much can be done and in what degree it will be successful.

On the next day the meeting ended and the gathering broke up; the castle again took up its peaceful and reasonable activity.

GOALS OF STELLAR NAVIGATION

Much is written and said here and abroad about the possibility of stellar navigation.

But what then will be the meaning of this achievement? What benefits can humanity extract from accessibility of celestial space?

Many imagine celestial ships with people, traveling from planet to planet, gradual settlement of planets and extraction hence of benefits which terrestrial ordinary colonies give.

It is far from that. About landing on big celestial bodies it is impossible now even to dream — it is so difficult. Even landing on such small bodies as our moon is a matter of distant future. Only such little bodies and moons like asteroids (from 10 to 400 versts in diameter) are fully accessible.

Main target and first achievements pertain to the sending of man into the ether, use of solar energy and everywhere scattered masses, like asteroids and still smaller bodies.

"What a rash thought," reader will say, "is it possible to live in ether without planet, without solid support under legs! ..Only large planets have atmospheres and can take man..."

But first, landing on heavy planets is hampered in technical respect. About

these difficulties only specialists can understand. Secondly, we encounter there atmospheres of unknown composition, with unknown plants and animals, with unknown temperature. One of these can destroy us.

In time we will master also the planets, but now this problem is far, far, and it is too early still even to talk about it.

If we even now took possession of all planets, then we would obtain comparatively insignificant reward. Really the value of planet is determined by solar energy obtained by it. Nevertheless the planets taken together obtain it only ten times more than Earth. All this is absolutely inconspicuous in comparison with full solar energy which is 2.2 billion times more than that obtained by Earth and 200 million times more than what all the planets of our solar system have. This is the kind of energy man can take possession of if he manages to settle in celestial space! Achievement of this goal can hardly be compared with discovery of two thousand million new planets such as Earth.

When we imagine clearly life in the ether, then we will well understand this "hardly."

Apparently, what could be more absurd than life in emptiness and without support! But this is not only attainable, but also presents advantages which it is extraordinarily difficult to estimate correctly.

It is necessary to consider how man breathes there, how he constructs dwelling, how he moves, raises plants, lives himself, eats, works, how he copes with technology, how he feels, marries, reproduces, etc.

Apparently the impossible, intolerant thing is absence of air or atmosphere. Partly this is true, but atmosphere is the source also of the greatest misfortunes for man. Neither the atmosphere nor its temperature nor any of its properties does man now know how to control. Let us take temperature. On equator in day time it is almost impossible to live because of heat. At night it is more tolerable, but damp and unhealthy. Northern countries have unbearable hot summer and unbearably cold

winter. What huge sacrifice and works its struggle with temperature of air, with winds, snows, showers, droughts, bacteria, etc., costs humanity! Atmosphere deprives us of huge part of solar energy: one part is reflected by clouds and another part is absorbed even by cloudless air. It robs us.

Neither people nor plants as yet can manage without gases. Man needs not less than half of that amount of oxygen with which he now breathes, i. e., such density of it (0.00012), at which pressure in cm^2 is not less than 100 g (0.1 atmosphere). Still insignificant impurity of water vapor is needed. Nitrogen and other gases are not needed, are even harmful, as useless impurity is harmful to bread.

Plants can be satisfied by insignificant quantity of carbon dioxide, oxygen, nitrogen and water vapor. This is their gas food. General pressure of this gas mixture does not amount to hundredth part of atmosphere, i.e., 10 g per cm^2.

This means that admixture of small quantity of carbon dioxide and nitrogen to atmosphere of man makes this atmosphere useful also for plants.

We will talk now only about similar atmosphere of man, how to preserve it from dispersion and to purify it from contamination. Although every creature, every plant needs special composition of atmosphere, like special temperature and special soil, we now leave these details.

Ordinarily vessel of spherocylindrical form, made of good material and sustaining internal pressure, weights ten times more than gas of elasticity of oxygen included. Let us assume that for man space with volume of 100 m^3 is necessary. Weight of m^3 of oxygen will be around 0.00012 t, weight of 100 m^3 = 0.012, weight of vessel = 0.12 t, or 120 kg, i.e., it will have mass two times larger than mass of man.

To sacrifice on dwelling of man 120 kg of glass, steel nickel and other strong metals these are such trifles! Even 10 times more is not a pity.

How is such a dwelling constructed? Its form is cylindrical, closed on two ends by hemispheric surfaces. The more extensive, it is the thicker the walls will be. Therefore the dwelling (so that thickness of walls turned out to be practical)

is constructed for several hundreds or thousands of men. It consists of shining, (on the outside and inside) cylindrospherical surface. Third part of it, turned to Sun, is a lattice with inserted glass. The latter is similar to curved frame with great number of glasses.

What form and what dimensions are the most profitable? Spherical form is inconvenient because connection between spherical surfaces is not especially easy to construct. Better in this respect are round cylindrical, very long surfaces. Thus dwelling has the form of tube, whose length is indefinitely great.

What is its diameter? It is the larger, the less sunlight is necessary per unit of volume, or for each inhabitant. This means that great diameter is not profitable, because light feeds plants, and plants feed man. But also small diameter is not good since it constrains movement, limits free space and gives small thickness of shell. It is possible to take diameter not less than 2 - 3 m. But, of course, it can be much larger according to assignment of dwelling. Meeting halls will be huge. Also factory and other public constructions. Their dimension is determined by their assignment. We now consider existence of family and its subsistence... According to calculation, shell of cylinder with diameter of 3 m will be unpractically thin. But nothing prevents us from making it 10 - 100 times thicker. Strength is increased many times, and material is not shabby.

But thick pipe, besides light advantages, has still others: the less its diameter, the larger the number of sections isolated from each other into which it may be divided. This decreases risk of being deprived of air and perishing in emptiness.

Let us assume, for instance that length of dwelling is 3 kilometers, diameter 3 m. Then it can be divided into 300 sections, each 10 m in length, 3 m in width and 70 m^3 in volume. This is a very respectable room, fully sufficient for location of average family. Its light surface amounts to 30 m^2, which is absolutely enough for kitchen garden feeding the family.

What is then the safety here? Let us assume that one of sections starts to release gas outside. Manometer will now indicate this. Then family departs to neighboring section, and the out-of-order one is isolated. It is inspected then outside and inside, jointly, in special impenetrable clothes and is repaired. Then family returns to its own bosom. It is clear that the more sections there are, the less the danger. There can be special attachments for automatic indication of place of gas leakage.

Air in section would be spoiled if there were no plants and their soil. But as on Earth rotation is accomplished, cleaning atmosphere and soil, so also in our little world, i.e., family section. We will give details when we describe growing of plants.

We will pay attention to temperature of dwelling. With described construction and at its distance from sun, equal to its distance from Earth, i.e., in terrestrial orbit, tolerable temperature is possible only with rotation of dwelling, when windows are turned first to Sun, and then in the opposite direction, i.e., when is obtained in dwelling alternately day and night. It is possible also with constant rotation of part of window to shadow side, when is illuminated inside approximately, 0.1 of entire internal surface (or 0.3 of projection).

Temperature in general will depend on us and can be changed from 250° of cold to 200° of heat, considering what part of sunlight we use. In one word, not only all climates of Earth can be obtained, but also climates of all planets of Universe.

One thing is not all right here. Economy requires that we use with help of plants or by other methods possibly larger quantity of solar energy. But then 200° of heat will be obtained and all will be burned. To lose light, turning from it, is a pity. There is simple means: this is to depart to another, more distant orbit, between Mars and Jupiter, nearer to first. If will depart twice further from Sun, than Earth, then we will obtain heat not less than what is necessary for man and plants for their brilliant development. Then no longer will it be necessary to turn

and to disregard gifts of Sun.

We can live a certain time also in orbit of Earth, but this is wasteful. At double distance we will obtain four times more solar space than at distance of Earth. In the same place we will find also much material, since this will be beyond Mars, already in asteroids belt. (There is a method and it is not wasteful, -- of using all solar energy without removal from sun).

Thus, what will be relation to us of sun, what will be in our dwelling thanks to it? We will obtain eternal day or eternal night, or alternation of one and the other, as desired. Plants can use eternal day, and man, accustomed (thanks to rotation of Earth) to sleep, can shield himself during rest with screen and use complete darkness. We will have always excellent weather and temperature according to desire. Clothes and footwear will be unnecessary. Abundant food — vegetable products. Infection will be impossible due to absence of contagious bacteria, insulation and always possible disinfection of every section by special method of increase of temperature to 100° C and more. At double distance from sun it is possible strongly to increase temperature. But about this later on. Is it possible to compare all this with unfortunate Earth?

We will proceed to very important circumstance and priceless present of ethereal free space: to absence of apparent weight. There there is mass, but gravity force are as if absent.

Our dwelling rushes with speed of several tens of versts per second, several million versts in twenty-four hours, considering distance from sun: the nearer to it the faster, and vice versa. But we absolutely do not notice this motion, as we do not notice motion of Earth. It seems to us that we are immersed in absolute rest.

On us act gravity forces of sun, planets, stars and all celestial bodies. But we do not feel them, as we do not feel gravitation of sun , on Earth. We on Earth sense only its gravitation. But in our dwelling — far from Earth; instead of Earth— tiny mass of pipe, which by its own smallness, does not render noticeable gravitation on us.

Gravitation of sun and other celestial bodies forces us to fall toward them and therefore to describe a curve similar to that which Earth describes. But fall of our dwelling and us is absolutely identical. Therefore we do not notice it, as we do not notice, our fall toward Sun on Earth.

Weight is as if absent, as apparently, motion is absent. There is neither weight nor motion, if we did not produce them ourselves. What are the consequences? Bodies do not press one another and do not fall. Building, as if it were not large (at least several tens of versts) cannot be destroyed and cannot fall anywhere. Struggles with weight during constructions are lacking. Only with planet dimensions of constructions (several hundreds of versts) parts of them, mutually gravitating, can render noticeable presssure on one another. With insufficient resistance of material they approach and are destroyed. But also the destroyed building can't fall anywhere, as Moon does not fall on Earth and both on sun... Bodies can be held motionless without any support and without contact with each other. Their direction also makes no difference with respect to rest. For instance, we in our dwelling are able, not failing, to hang (without rope or other support) in air, turning head to sun, or legs to it, or sideways — as we want.

Loads do not exist for us, only masses exist. Any mass we can hold in our hands, not experiencing the least weight. It can be on head, on back, or under legs — we all the same do not notice it. Hence it is clear that for us there is no need not only for clothes and footwear, but also for furniture. Why chairs, easy chairs, beds, mattresses, pad, etc. Man isn't pressed to anything, no body presses him, any place is as "soft", as no downy bed can be soft.

Why interlay delicate fruits, glass dishes and brittle things with straw, sawdust, cotton, or rags, if there is no mutual pressure... Is all this not a great advantage over our medium?

Top and bottom does not exist. While man is not accustomed, top seems above head, and bottom under legs. This means, that top and bottom change as desired.

What is it to feel the first time oneself without support and abyss under legs. Then illusion of top and fear disappear. But the first time for soothing are necessary, dwelling, walls and floors and even contact with them.

Now let us consider motion. We will not speak of true motion, of which there is in general, none; there is motion relative to Earth, Sun or any other body, absolute motion is unknown. But we reject even our planetary moti n (our dwelling rushs like planet), i.e., motion relative to Sun. After all we do not notice it and we will not talk about it now. We consider only motion performed by us, by means of muscles, machines or anything else.

Totality of dwellings having huge extent in length and width and huge mass we will consider motionless, as considering terrestrial human motions we consider our planet motionless.

We, for instance, are in extensive room, where we make various experiments of motion.

Let us assume that anywhere in middle of room there is some stone, table, commode or other object whose parts do not interact and do not shift, as for instance in working machine or in animal, i.e., we imply one solid inorganic body.

With great effort we can make our object (table) motionless. Let us do this. What will happen? It will remain eternally motionless, i.e., will not revolve or shift relative to walls of our room. The position we gave it, it will remain in forever.

We could do the same with man: also make him motionless, asking him not to move his limbs. Then he will neither approach the walls nor go away from them.

But here we will give him freedom of movement and will ask him to use legs, hands and what he wants, and to approach us. What will we see? He will writhe, all his limbs will come into motion, but he will remain in place (if we imagine that around him is emptiness). He absolutely freely waves legs, hands, bends like crushed worm, turns head to the right and to the left, takes all positions (sedentary,

standing), directs hands and legs in all directions, but center of his weight remains as if nailed. He remains in the same place and shifts not one centimeter.

We ask our friend to spin around, as children spin. But he can't do this either, in spite of all his efforts and desires to execute our request. When fatigued he calms, then his face is turned to the same side as in the beginning, when we made him motionless. Direction of his body also was not at all changed.

If matter is thus, then how to move, how to direct oneself in various directions and shift? Nothing can be easier then this. It is possible arbitarily to revolve and to move in all directions — both in gas medium, and also in vacuum. In gas medium palms of hands are sufficient. They can serve us as wings. Quickly we would learn, pushing away air, to revolve and to move where convenient. But palms are bad wings — their surface is excessively small. It is necessary to take in hands light blades approximately 1 m^2. With their help it is possible to turn and to move very quickly. Wings can be also less. After all it is not necessary to conquer gravity, it is necessary only to struggle with inertness of body and resistance of medium, i.e., with its inertia and friction. The most insignificant efforts are needed for this, if only speed is ordinary, for instance, of walking.

But both in air and in vacuum it is possible to use other methods. In a vacuum they are obligatory, since in it other means of motion are lacking. In air of our dwelling they are not needed, here wings are sufficient. Nevertheless we will continue experiments in our room, disregarding resistance of medium, which is not great at ordinary primitive speeds of man.

We saw that man could not set himself in motion, i.e., obtain forward movement or rotation, could not even turn to the other side. Random motion of members was obtained and that only. Finally all remained in former state.

But let us imagine that man is dressed. He removes hat or coat (this is possible) and throws them aside. Things rush, but also he does not remain in place. He slowly shifts to opposite side, until he bumps against wall. If there were no

obstacle, his motion would continue eternally, evenly and along a straight line.

The larger the mass of the thrown-away object and the stronger it is thrown, the faster the man shifts. If two people of identical mass pushed away from each other, then both would move with equal speed in opposite sides. If one pushed away from two or from double mass, then he would obtain speed twice greater than the pushed away two.

With this it is difficult to avoid rotation: masses pushed away from each other still revolve. In general their motion is like motion of carriage wheel, planets, children's top, etc. But theoretically pushing away without rotation is possible, i.e., pure forward motion.

Let us consider rotation separately. Again we will turn to our dressed man. We will ask him to remove cap or boots and to turn them in the manner of toy-top. Now we see turning boot or cap. But also man, having removed it, slowly starts to turn. In one word, he slowly was turned, as also his cap, only in the opposite direction. The more massive and more extensive the thing which he turned, and the faster it turned, the faster our man turns. If two men of identical form and mass turned one another, then both would have identical angular velocity of rotation. If however one was turned around his own height, and the other around his own width, then the last one will revolve slower, since moment around transverse axis will be larger.

In air, of course, rotation (in virtue of friction) sooner or later would be ceased. But in vacuum it would be eternal and uniform, like uniform and eternal motion of planets. And the two turned men, like dolls, will revolve eternally. Their will is not able to destroy this motion, as also motion forward. But if they again link with each other, then motion of both will stop, i.e., there will not be rotation.

Let us imagine group of people without support, absolutely motionless and not revolving. General center of their weight is immovable. Torque forever is equal to

zero. But each of them can arbitarily twist, grimace and take any poses. Motions of all their muscles are free in the same way, as on Earth. Pushing away from each other, they can obtain any rotary and forward motions. Any subject, obtaining such, if he cannot grab the general group or is not connected with it by a rope, never will lose either his own rotary or his own forward motion. He will move eternally, uniformly and in a straight line. He will forever remain a children's top, and forever will be separated from his friends. Thousands, tens of thousands of versts will pass and nevertheless he will not stop. All can disperse where they want, but center of their weight will remain nailed to one place of space.

In order to stop motion, another body is necessary available for us to impart reverse rotation or reverse forward motion. If it is insufficient, then motion of main body only will be delayed, if sufficient - then it will stop, if it is excessively fast, then it will not be ceased, but will change direction.

It is clear now, how to excite and how to cease motions in air. In dwelling it is possible to push away from its walls, from any objects, or from air with the help of small wings, of course not having weight. In vacuum the matter is more dangerous and more difficult. Here it is necessary to have support, i.e., another body, although not connected with dwelling. It is possible to use rocket, compressed gas or steam, any solid or liquid body.

It is possible to manage also without movable support and without throwing away of bodies (which fly away from us forever), if we connect ourselves by rope of wire to dwelling. Then we pushed away from it on desirable side and fly as long as leash does not stop us. Then, for return we are drawn along rope to dwelling.

This means that motion in the ethereal void, in medium without weight, can be of three main sorts. Straight line and uniform without rotation, rotary with immobility of center of gravity and axis of rotation, and mixed, i.e., combination of eternal rotary with eternal forward — straight line.

There is still more complicated rotation, with which oscillation of axis of

rotation is connected. But it is unstable, i.e., uneternal and gradually changes into simple rotation around free (special term) axis.

We are not talking here about complicated bodies, parts of which are mobile, or about living bodies. These and others can eject visible or invisible particles. And therefore the indicated laws of motion will be, it appears, broken. Thus, any animal continuously gives off various substances, for instance vapor and gases, and therefore is likened to jet instrument. Man in our dwelling, being at first absolutely motionless, under the influence of ejecting gases and vapors, nonuniform circulation of blood, motion of heart and other organs, — gradually obtains not only rotary, but also forward motion. Only this is not at once, but after significant interval of time.

If however there are no ejections, then all bodies living and dead, as if they were not complicated, obey three laws, namely:

A. If center of gravity of complex body is at rest, then this rest cannot be disturbed by internal forces of body.

B. If center of gravity has motion, then also this motion cannot be changed by internal forces neither in magnitude nor in direction, i.e., this motion will be eternal, uniform and in a straight line.

C. Here the third (an extraordinarily important law) pertains also referring to rotation of complex body, motion of whose parts and relative position constantly changes: rotary moment of inertia of this body forever remains constant (about moments of any kind see mechanics).

This law has, for instance, application to compressed suns, nebulae, planets, and solar systems. Its applications are infinite. Thus, if revolving group of people, linked together by hands, are pulled into denser group, then it will accelerate its own rotation extremely, the stronger the denser the group is made, and vice versa. Not only with this is angular velocity strengthened, but also absolute...

What does man feel, revolving or moving without rotation? Again we will observe

him or ourselves in dwelling. From lack of habit forward motion is not at all realized. It to us appears that we do not move, but walls surrounding us. Also we do not realize our own rotation. It seems not our own rotating, but rotating of rooms. It seems to us that someone turned our dwelling. We, inhabitants of Earth, also turn with it, and move forward, and have yet with it hundreds of various motions. But all them we sense not as our own motion, but as motion of celestial bosies surrounding us. Only motions done by us ourselves do we realize and sense. Great number of motions of Earth do not exist for our senses.

But after all, there in the ether we do ourselves little motions. Why do they seem to us not ours, but strange? Cause is the smoothness of this motion, its inconspicuousness, due to the absence of shocks, shakings and other results of terrestrial, not ideal motion and rotation.

Nevertheless these illusions, at least in dwelling, should in time disappear. At first it seems to us on steamer that shores move, but then we realize the motion of vessel, no matter how quiet and even it is. Thus it will be, probably, in the ether...

Till now we have talked about rest and motion in dwellings. But what will our sensations be outside them, in infinite free space of universe, in bright and burning beams of Sun?

Already through windows of building we can see many things. Sky is black. Patterns of stars are the same as on Earth, only there is less redness in stars, and more variety in their colors. They do not flicker, do not sparkle and with good vision seem dead points (without rays). Sun also seems dark-bluish. Earth seems a star, like Venus, and our moon is hardly noticeable. Pattern of constellations does not depend on our position in planet system, it is all the same: both from Jupiter and from Mercury, but the magnitude of the sun only from terrestrial orbit is such.

Due to absence of atmosphere, we see stars, neb[illegible], comets, planets and their satellites extraordinarily distinctly. It is evident that on Earth it is impossible

to see without telescope. With the help of the latter it is possible to behold what we never saw from Earth...

Special clothes, with supply of oxygen and absorbers of human excretions, allow us to emerge outside the dwelling.

We will be placed in its shade. Sun is visible. General picture appears very strange. We feel in the center of a small black sphere, strewn with polychromatic points, stars and foggy specks. Furthermore, through the whole sphere stretches wide foggy band of Milky Way, here and there bifurcated. Each time, shielding from sun, we are plunged into night. Departing from dwelling and not emerging from its shade, we simultaneously will see almost the entire sky, the entire sphere.

Sun would kill us by its ultraviolet rays, if ordinary glass of our clothes and dwelling did not protect us from them. On Earth atmosphere saves us from them.

Emerging from shade, we will see sun. It will appear to us much smaller than from Earth, decreased the same, as the celestial sphere. This is subjective: it did not decrease at all.

It is difficult to imagine what man feels in the middle of the Universe, in the middle of this miserable black sphere, adorned by polychromatic brilliant points and daubed with silvery fog. There is nothing for man either under his legs or above his head. Maybe it seems to him, that he, any minute will fall to bottom of this sphere, on that side where his legs are turned.

Pushing away from dwelling, he will describe straight line and it is as if he should depart from place of his own residence forever. But that and the other is not quite true. Gravitation of sun will force the pushed away one to describe circumference around luminary, on whatever side he did not direct his own path. This means, that the line will not be a straight line, but a curve. But one degree of this circumference (at distance of Earth) amounts to more than two and a half million versts. Hence, path nevertheless can be considered a straight line for hundreds of thousands of kilometers. If man with this floats a meter per second (speed

of pedestrian), then his path for several years will be straight as arrow. He will fly the entire circular orbit then in 30,000 years. But also after that he will pass so far from his dwelling, that he will not notice it.

If however humanity already has spread into huge celestial sphere and has built along and across it dwellings and other constructions needed by him, then the pushed away creature will not be helpless. He everywhere sees or runs against human buildings, obtains information, directions and returns where he wants.

How spacious is this field of the solar system, this sphere which man can occupy. At double distance (comparatively with Earth) of its surface from sun it is 8.8 billion (almost 9) times more than area of the biggest section of Earth (its projection), or 2.2 billion times more than its entire surface. This sphere also obtains as much times more solar energy comparatively with Earth.

But the latter does not obtain it completely; more than half is reflected by clouds into celestial space, part is absorbed by the atmosphere, part fruitlessly falls into oceans, on deserts, on mountains, and on snow fields. In general result Earth obtains hardly more than 10% of what was apportioned to it.

Thus, the value of this sphere, of its eternal day, of virgin beams of sun is still 10 times more and is expressed as 22 billion with respect to Earth.

Free space of this brilliant field can't be determined by this figure. It is a million billion times more than terrestrial. However not it but solar energy has the principal value.

Certainly, motion and its laws outside constructions are the same as inside them. But sensations are more wonderful.

Forward motion is not noticed at all and will be registered by surrounding artificial bodies. It is not at all reflected by position of stars and planets. So that if there is nothing around people and their buildings, then all seems motionless.

But it is difficult to obtain strictly parallel forward motion. It would be

inconspicuous, if it was not mixed with rotary motion. The latter, if it is weak, then it will not be registered itself, but forces us to think about rotation of black celestial vault. Axis of rotation of our body become axis of world. Thus, if we revolve around our height, then above head will be one pole (from "polar" star), and under legs another. Remaining stars will describe circles in the same time in which man makes his own turn. For instance, if it is in 10 minutes, then stellar sphere also will make its own turn in 10 minutes. Fast rotation may cause dizziness, illness and even death. And therefore it can be recognized by man by his own consequences.

It is difficult also to dismiss the illusion of up and down. One always conceives of "up" above the head, even if this head is lowered and raised all the time due to rotation of body around its transverse axis. It will appear to us that it is the stars which are lowered and rise. We do not believe, in lowering of head: it is as if motionless and above it is top.

One confuses also down under legs without support. It seems that we will fall there. Absence of support — floor or soil also surprises...

We are not concerned here with the beginning of cosmic life. Its support is on Earth. First dwellings, tools, machines, plant nurseries, workers, etc.— all this will be delivered from our planet. We can only describe here a gradual transition of resettlers to autonomous activity independent of Earth, development of industry, population and its expansion into celestial spheres. Thus, colonists first are fed by brought reserves and only gradually are strengthened and attain independence, prosperity and expansion.

We assume this beginning of life is already prepared. It remains to us only to describe it. But how it is prepared on Earth and transfered into the ether — this does not concern us...

Can't the absence of weight damage the health of man? Gravity strengthens influx of blood to legs. Removal of it, conversely, strengthens influx of blood to

brain. Therefore man with weakened walls of blood vessels, inclined to a blow (apoplexy), risks death during submersion in water, or in lying position, or all the more so with legs upwards.

In water and in lying state blood pressure becomes almost uniform, as in the absence of gravity. Therefore the absence of gravity is as harmful or useful as lying position. To sick and weak such a position is useful, it is even necessary. Therefore medium without gravity for them, physicians and footless — is pure paradise: there are no bedsores, all parts of body are accessible and all motions are free. To the healthy lying with passage of time becomes unbearable. But after all, this occurs more from the fact that lying necessitates physical idleness. If one could work muscles in bed, then wearisome sense would disappear. It is dull to lie— there are few impressions. This also is a cause. In medium without gravity work with any muscles fully depends on us.

Gravity promotes defecation and swallowing. But after all, all this can be done also in horizontal position. Consequently, absence of gravity here also is not obligatory. Acrobats manage to drink and eat even legs upwards, and this is not a deception.

Standing position on Earth brings forth known illnesses and therefore surplus of it is directly harmful.

In ethereal dwellings dishes, instruments, and any objects of everyday use do not require baskets, shelves, supports, stands, etc. This is good. But, not having weight, from the least forces, even from inevitable motion of air, they do not remain in place, but roam all over rooms, like living things, like dust motes.

This is unbearable and dangerous: during breathing a pea, nail, pin, etc., can get in throat and kill man. But all small bodies can be kept in light packs, cases, boxes, or bags. Larger things — in nets. This is very easy, since the least force is sufficient for that. It is possible to hold them also on short leash.

What to do with soil necessary for plants? With the least shock, friction,

motion, air currents, or dryness — it breaks off from its place and rushes into air in the form of dust motes and grains of clay, sand, lime, etc. This also is impermissible. Strong winds also on Earth carry not only dust — it is always in the air — but also big sand grains, even stones, leaves, insects, etc. But without gravity the matter is much more serious and more general. Certainly, air before serving for breathing should continuously be strained through sieves, fabric and different liquids.

But this is small. Here it is necessary to resort to stimulation of artificial gravity. There is no need to make it as great as terrestrial, and thus to burden people for struggle with it. Absolutely sufficient is gravity of one hundredth or 0.001 of terrestrial. We will pause on latter, the weakest. With what is it not sufficient? Under its influence all big bodies will fall to artificial bottom, i.e., to floor, since then floor and ceiling and cabinets will appear. But drop will be slow; in one second body will fall only a half centimeter, in 10 seconds a half meter, in a minute — 18 meters. It is clear that minutes are sufficient to free highest room from roaming bodies — both large and small.

In special dwellings for plants artificial weak gravity is especially necessary to keep soil in place. Certainly, dust, sand grains and wandering of bigger bodies is not dangerous to plants. But still they are harmful, since they shield them from sunlight. Furthermore, how will plants live, if all the soil disperses into the air?

In ethereal medium obtaining of artificial and continuous gravity costs absolutely nothing. Only if it is great, then dwelling of plants and man must be made somewhat more durable and therefore more massive.

Gravity is engendered by rotation of body. Rotation in vacuum is eternal. And therefore gravity will be not only eternal and constant, but also not costing any trouble. The faster the velocity of particles of body on circumference, and the smaller the radius of this circumference, the stronger the gravity from centrifugal force and vice versa.

We will imagine a long conical surface or funnel, the base of wide hole of

which is covered with transparent spherical surface. It is directly turned to sun, and funnel rotates around its own long axis (altitude). On opaque internal walls of cone there is a layer of humid soil with plants planted in it.

Here is a method to use fully solar energy without excessive increase of temperature, even at distance of Earth from sun. The longer the cone and the larger its surface, with the same transparent base, the lower will be the temperature inside the cone. At distance of Earth this surface should be four times larger than glazed area. For this it is necessary that generatrix (a little larger than altitude of cone) was 2 times larger than diameter of base. Nearer to sun the cone will be longer, and further—shorter. Even at the closest distance from the sun temperature of cone, its plants and gases can be made tolerable. Thus, at distance 10 times less than terrestrial, cone must be extended 100 times. Its base will be 200 times shorter than its altitude.

Only to connect revolving cones by passages is more difficult than the described cylindrical dwellings of man.

But it is profitable to make dwelling of plants separate, since they do not require thick atmosphere and strong walls. Thus, besides economy of material, special (although rarefied) atmosphere gives the biggest harvest. Accidental destruction of plants from leakage of gases is not important. One thing is not quite convenient: excretion of people should continuously enter greenhouse, and products of vital activity of plants (gases, fruits, etc.) should enter dwelling of people.

In our cones solar rays indirectly illuminate plants and therefore their action is weaker. In cones they make not only eternal day, but also eternal spring with determined desirable temperature most favorable for raised plants. Rotation of them and artificial gravity engendered from this holds humid soil and vegetable waste materials in order. Ripening and separated fruits we will find falling to soil, but not roaming in free space of cone.

In dwellings and other constructions of man also weak gravity is not useless.

Magnitude of it 0.01 of terrestrial cannot hamper movement and work. We will assume that we have compartment in the form of a sphere with diameter of 2 versts. Sphere slowly rotates around its own diameter. Speed on circumference (equator) is near 10 m per sec. Full turn is accomplished in 600 sec. or in 10 min. The biggest gravity, on equator, is one hundredth of terrestrial. Jump from internal circumference to center lifts man 100 m, so that motions are not constrained and gravity is not noticed.

Phenomena of motion in such a sphere are complicated and we will not describe them now.

Types of dwellings of man and plants can be infinitely various and we will leave this now.

We will explain a very important thing: how definite temperature, humidity, definite composition of air and good food for plants and man is achieved in joint dwelling.

Easy rotation gives rise to gravity, gets rid of litter and settles order. Glass-thin, transparent, and permeable as far as possible for all kinds of rays is quartz or something else. Rays are weakened by it and by thick wall of vegetation. Therefore they are safe for man. Plants are selected fertile, grassy, small, without thick stems and parts not working on sun. The more they utilize sunlight, and the more they give fruits, the more they absorb solar energy and heat. But it returns, since fruits are eaten and people return to their own dwelling heat absorbed by plants, only with accumulation of fruits (reserves) does this heat temporarily lag.

Plants should be so many, that their roots, leaves and fruits give as much oxygen as inhabitants of dwelling absorb. If the latter absorb more, then people choke and weaken, and plants revive from surplus of carbon dioxide: if less, then people breathe easily, but plants do not have enough carbon dioxide and weaken. Equilibrium maintains itself with successful selection of plants. Regulation is accomplished also by number of tenants. In a word, the number of people should correspond to

the characteristics and number of plants.

Whence is water for plants and man, of which, it seems, very much is necessary? Its quantity is definite and does not change; it does not decrease and does not rise. How is this so? Plants, animals and soil in dwelling continuously evaporate water. But these vapors cannot disappear in tightly closed dwelling. They are accumulated in condenser in the form of water. Shady part of compartment has sections with any low temperature. It is necessary only to turn section to dark celestial space and to insulate it from internal heating (similar to home wall cellars) and we will obtain desirable low temperature. Into these sections is passed more or less humid air, where it leaves as much vapor as we want, since this depends on speed of circulation and on lowness of temperature. Both of them are available to us.

Water from condensers goes for drinking, for ablution, for watering of plants or moistening of soil. But not only water continuously circulates from plants to condensers and back, but air also does the same. It is passed with help of special pipes into soil and, already impregnating roots and bacterium, emerges outside fully purified and suitable for breathing.

Human excretions are diluted with water and also proceed to soil, where bacterium quickly make them suitable for feeding of plants.

In these compartments of ours is necessary neither constant flow of water nor flow of food for plants and animals. Definite reserve of gases, water, soil and fertilizers serves without exhaustion.

On Earth the same is accomplished, only on a large scale. But on Earth fertilizers pass into oceans and sometime will be extracted from there. In our dwelling, if they are expended, even if they are accumulated in fruits, then they immediately return without any losses. And on Earth in time we will find profitable insulation of plants, their food and water. We will start this with deserts, where it is insufficient.

Thus, atmosphere is clean, air is humid as desired, temperature and composition

of atmosphere are regulated also as desired. We have eternal inexhaustible source of distilled water, oxygen, heat and food. Clothes are not needed.

There is no gravity, legs do not swell, branches of plants do not bend from weight of fruits. Saps of plants freely spread, not being constrained by gravity.

Although we also use weak artificial gravity, it is so small that we can disregard it, forget about it and consider ourselves in medium free from forces of gravitation.

Temperature of dwelling fully depends on us. What can be the need for clothes! <...> All who wish are permitted to be covered; for others plain body, any abnormalities, old age. All can wear as many clothes and ornaments as desired with the consent of society.

In general, we in one moment can give desirable temperature to old men, sick, premature infants, etc., who are sensitive to cold. Certainly, it is necessary to construct dwelling according to properties and desires of population. Those wishing always to have high temperature can be found. Inhabitants of equatorial countries, sick, and weak old men will demand 30° C. Others — 25, a third group — 20 — all different. Every building can satisfy this. The same compartment can change temperature. Thus, for sleeping increased temperature is required; after all there are no feather-beds, nor mattresses, nor pads, nor blankets nor night clothes. For meetings in large halls it will appear hot to one, cold — to another. Let us assume that we set in hall 30° C, i.e., 24° R. In this case no one shivers even without clothes, but some feel hot. If however we fix 25° C or 20° R, then without clothes weak will chill and it will be necessary to dress them.

Change of temperature direct sunlight here are used for the most various purposes. For instance, for disinfection of soil, atmosphere, walls and all subjects of dwelling. People and plants depart from it for this, and temperature is brought to 100 - 200° C. It is clear that all living things will be destroyed. This is why agriculture will be facilitated; there will be no pests. Pure culture of desirable

plants will develop.

In connection with selection of them, with suitable temperature, atmosphere and feeding — what wonderful harvests and excellent fruits we can obtain. And this is without the least trouble; after all there is no need to weed, to destroy insects, to struggle with droughts and showers...

Chemical processes, for instance processes of rotting and fermentation, with which various alcohols, vinegars and other substances are obtained — require a definite temperature. We give them it. Our factories obtain it, if it is not higher than 200° C, in buildings similar to dwellings. If however it is very high, then we use special constructions, where heating also is done by the sun alone.

Water and all possible very clean fruits, free from any contaminations, quench our hunger and thirst. Neither colds nor contagious diseases are possible. The very body of man, permeable to rays of sun, is liberated gradually from any harmful bacteria. The further this occurs, the more will humanity be liberated from harmful beginnings with which he is now born.

Once man has dwelling with desirable temperature, virgin sun, day and night — as desired, as much water as necessary (one reserve forever), food, — once he does not need clothes, moves where he wants without any effort — then what does he still need?

But first he reproduces, since this is profitable to him (the more population, the more ideal the social system and the more genius — leaders). This means he needs new dwellings, i.e., material and treatment of it is necessary. Secondly, he studies substance and the universe. This means that he needs the same instruments which scientists use on Earth. He improves plants and himself. All this requires newer and newer apparatuses. Production of them requires great number of shops and factories, for purpose similiar to terrestrial. Utensils are different, but after all it is inevitable. Books — also, etc.

First time we will use materials from Earth. But delivery from it absorbs

large work. Delivery from Moon and small planets is easier. It is still easier to use asteroids with diameter of several versts and still smaller bodies, of which there are any number between planet orbits, especially between orbits of Mars and Jupiter.

On tiny planets there is no atmosphere and no liquids, but in them there is as much as desired of hydration and water constitution, gases, non-metals and metals of all sorts. It is necessary only to decompose chemically dry minerals.

We need mechanical forces. Whence to take them? Mechanical forces in our ethereal region are two thousand million times more than on Earth. It consists of rays of sun. To extract it is possible by means of plants and directly — from solar rays. Sun can give us wood, carbon, starch, sugar and infinite number of substances delivered now by plants on Earth. They are the same source of force as coal, waterfalls and wind on our planet. This source of energy is used as on Earth, i.e., in dwellings where there is oxygen. But this is inconvenient, since their atmosphere is spoiled quickly.

It is possible also directly to use heat of sun in exchange for heat of burning. Here on Earth this is inconvenient and unprofitable for reasons; bodies heated by sun are cooled by air and wind. Sun shines only by day, when it frequently is covered with clouds, and its heat is always absorbed half by the atmosphere. Force of rays is inconstant from their variable slope, there is no good condenser with low temperature; mirrors, gathering heat, dim quickly from air and humidity. They are heavy, brittle, expensive, and cannot be as large as necessary. All this makes unprofitable use of sun for device of thermal motors on Earth.

It is quite another matter in ethereal vacuum, in medium without gravity. Here in one place can be obtained, even without mirrors, 200° of heat and alongside (at 1 m of distance) 270° of cold. Thus can be used with great utilization the heat of steam motors working with steam, ether, alcohol and other liquids.

It is clear that I give only the example of motors, but they can be of quite

another sort. We will describe steam motors in the simplest form. We have two identical vessels, insulated from each other with respect to heat. Rear is in shade of front, turned to rays of sun. Front side has a black surface absorbing rays well. It and liquid under it in vessel are heated by sun not higher than 200° C. Vapors of liquid before crossing to condenser, i.e., in rear vessel of such a device, like the front — pass through ordinary steam engine or turbine. With proper selection of liquid and arrangement of machine, utilization easily can reach up to 50%. Such a machine will give for each m^2 of black surface turned to sun more than one horsepower.

When almost all liquid crosses from front vessel (steam engine) to rear (condenser), then vessel is turned by condenser to sun, and steam engine to dark celestial space. In a word, roles of absolutely identical main parts of instrument change (automatically) approximately every hour, considering volume of boilers. The latter, of course, are composed of pipes, as carpets of threads. They cannot lose, since everything is tightly covered from leakage of steam.

We cannot now say what kind of motors will be in use. Probably very many sorts and systems which it is now impossible to anticipate.

Boilers can have surface of any magnitude, since gravity does not prevent this. This means that their power can be any...

Essence of factory industry consists of the following.

A. From minerals their component elementary parts are obtained, for instance gases, liquids, non-metals and metals.

B. From elements compounds necessary or useful to us are constituted, for instance gases, spirits, paints, medicines, nutrients, acids, alkalis, salts, fertilizers, alloys, etc., (both elements and needed compounds sometimes are found prepared in nature).

C. Alloys or other building materials and in general, solid substances take necessary form, for instance, as instruments, machines, utensils, scientific

instruments, paper, fabrics, clothes, pressure suits, dwellings, factories, etc.

For all this (A,B, C) on Earth the following means serve: increase or lowering of temperature and pressure, electricity, catalysts (insignificant impurity of various substances which promote chemical process), and mechanical forces.

Of course, we can't manage without instruments. Their prepared samples already are on Earth and the same will be used outside the atmosphere...

At first people had no instruments, as animals, then they had very simple ones. With help of these primitive ones, a little better ones were built. From the best— still better, etc., until the present was reached, arousing in us deep astonishment and enthusiasm. Their progress never will be completed, and in the ether it will deviate to one side, inconformity with new conditions...

It is known, how on Earth increase of temperature is obtained. But here in the ether we do not need these means, except in exceptional cases. Here increase can always be obtained by power of solar rays — very economically and to any degree, — from 273° of cold to temperature of sun.

For obtaining the lowest temperature luminary is shielded with brilliant screens and radiation of black bodies in celestial space is used. With this temperature of 273° of cold is obtained.

The thriftiest heating, exemplarily, is such. Chamber of desirable magnitude and form is closed on all sides, in several layers, with surfaces reflecting rays well. Thus heat is kept inside chamber, is reflected back inside it, and temperature hardly drops, as earlier it was not high. This is like a thermos, but only much more perfect, which is promoted by several shells and absence around of material medium, for instance air.

Heat of sun penetrates the chamber through a small hole. Parabolic mirror behind the chamber (with dimensions larger than chamber) collects rays of sun into small focal group, precisely the magnitude of hole of compartment. Here rays diverge and heat space inside the chamber to temperature of sun, however small the mirror

was. But this is with ideal conditions; with full preservation of heat, with point-like hole and with efficiency of reflecting mirrors. In reality there is nothing of that kind, and therefore heating only then is close to temperature of sun when dimension of mirror is many times larger than dimension of chamber. Then, some inevitable heating of its walls worsens their reflecting ablity and also hinders obtaining of temperature of sun, i.e., 5 - 10 thousand degrees of heat.

In focus of parabolic mirror image of sun is obtained. The less it is, the less the hole of the chamber, the less will be the loss of heat and the higher will be the temperature of the chamber. But, on the other hand, inflow of heat is proportional to surface of mirror. Let us assume that radius of mirror is 1 m. Image of sun will be in main focus, at distance of half a meter from mirror. Angle of solar image at distance of half a meter will amount to around half a degree (like angular dimension of sun from Earth). True dimension of solar image will be (mm) equal to sine of half a degree, multiplied by 500 mm. We will obtain near 4.3 mm. If radius of curvature of spherical mirror is not one meter, but P meters, then image of sun will be P times greater, For instance, for mirror with radius of 100 m diameter of the image will be near 430 mm. Thus, the larger the radius of the mirror, the bigger its image, the bigger the hole in the chamber and the bigger — both the expenditure of heat, and also its inflow. We assume all mirrors similar, i.e., components of the same part of full spherical surface. Under these conditions it appears that temperature of chamber will not depend on dimensions of mirror. But it is not at all so: a large mirror gives the highest temperature in the chamber, because it loses not only the hole in the chamber, but also its entire surface, therefore we have still an advantage of large mirrors: speed of heating bodies located in the chamber is increased with dimensions of the mirror. Furthermore, they give more heat per unit of time, and if this heat is absorbed by chemical processes inside the chamber, then also processes are accomplished faster.

We will imagine for simplicity a round mirror, like a saucer. It constitutes

part of spherical surface. We will draw from center of imaginary sphere a radius to rims of mirror (saucer). We will obtain angle. This angle cannot be more than 180° (half sphere). But such a large angle is almost useless, since it catches rays somewhat more than mirror with angle of 90°, even 60°. The last angle we will also take for mirrors of all dimensions. Their diameter always will be equal to radius. Thus, if radius of mirror is 100 m, that width of mirror will be also 100 m, and dimension of image = 430 mm. It is always 233 times less than width of mirror. Presenting chamber with full sphere, we will find that practical width of mirror is not less than double the diameter of chamber. If for instance the chamber is 1 m, then dimension of mirror is not less than 2 m. Fourth part of its surface will be in shade from chamber. Therefore it can be made ring-shaped. But also vanishing 1/4 share of solar energy can be utilized by means of convexo-convex glass or special mirrors. And one or the other will be in front of chamber, nearer to Sun.

Mirrors can be of huge dimensions, since also with thin surface of them and small massiveness they are intact, not bending from gravity, (which is lacking). For more regular form it is useful to give them weak rotation together with chamber, with which mirror constitutes one integer.

Such instruments, in connection with pressure and catalysts, are used for completion of some chemical processes requiring definite temperature. The latter is easily regulated by magnitude of surface of mirror and by screens of various kinds. If definite pressure is also required, then hole must be tightly covered by screen transparent for rays.

But the same chambers can be used for heating prepared alloys for the purpose of casting, pressing and forging them — for imparting desirable forms.

Now we will turn to mechanical influence for treatment of cold or heated, solid and semisolid materials. We already talked about the simplicity of arrangement of motors, each m^2 of whose surface yields one force. For obtaining it, of course, it is possible to use both mirrors and chemical processes. This means that mechanical

energy is as much as desired. (It easily is converted by known methods into electrical, — if it is impossible to do this directly by solar radiation. Electrical energy of high potential, as is known, can give temperature higher than solar).

Will machines work without gravity? Support for them, if it were needed, we always have in massive multi-chamber dwelling or special locations. Let us consider now the action of certain machines in medium without gravity.

Carbon and wood will fly out of furnace. If however furnaces are fenced with grids, then small particles of carbon will slide out of furnaces. Furthermore, thin grid will burn or will be melted. Wood and carbon will not lie on bottom of furnace, and will spread all over its space to the very ceiling. This, probably, is tolerable. There will be no natural thrust and therefore artificial is necessary. Hence it is clear that coal, wood, peat, etc., furnaces are inconvenient in medium without gravity (besides the absence of extensive oxygen atmospheres). But, first, we do not need ordinary furnaces in the ether, secondly, if need for them occurred, then we could apply coal powder, liquid fuel and artificial thrust. In general, in medium free from gravity, heating is done by sun, and cooling by radiation of bodies.

We saw that in motors sometimes boilers with liquids will be used. The latter will not occupy lower part of vessel, because bottom is lacking, and they will be distributed chaotically all over space of boiler, pell-mell with their vapors. Thus, together with steam also liquid, will escape which is inconvenient. But it is possible to set the boiler in order, if it revolves or if during its immobility inside it the liquid revolves by means of a wheel with blades. And one or the other is easily realizable in medium without gravity. Then liquid will be distributed along equator of boiler, axial part of it will be occupied with steam...

Let us imagine any factory. Wheels turn, various rods shake, shavings fly, workers mill around like fish in water. If entire factory revolves, then in it gravity will be formed and conditions of work will be the same as on Earth, somewhat deviating only depending upon magnitude of artificial gravity. If rotation is lacking

or weak, then gravity almost is inconspicuous. Waste materials of various kinds then must be gathered in special stand boxes, air constantly filtered for dust and flying small bodies. Magnets can collect iron, steel and cast-iron shavings and filings.

But in many industries (for instance, rolling industry, press working industry) there are no wastes or they are harmless and easily removed. There artificial gravity is not even necessary. At last, when waste materials threaten worker, then his head can be protected in any case with net or glass, and mouth with special pad. Special clothes also serve as protection. Even on Earth are we guaranteed from waste materials in the form of flying insects and fast flying shavings?

Workers and engineers fly among the machines and products and therefore can get between wheels, levers and other moving parts and maim themselves. But dangerous places can be fenced with grids. Control of machine parts can be outside machines, in special place. All this is not new and has been used long even on Earth...

Processed thing in medium without gravity, as though it were not great and massive, does not drop, does not twist, does not press workers and easily turns and is shifted on all sides. Also workers can do their business in any position and in any place, not fearing to fall with any welcome pose (for instance, legs upwards in relation to each other). Only support is necessary. But he always will find it, linking legs or own body with processed object itself or with machine. Convenience of work in medium without gravity is above any praises...

During various kinds of work on Earth gravity is not so much used as inertness of massive bodies. Hammer works in medium without gravity just as well as on Earth. Force of its blow depends not so much on gravity as on speed of its motion, depending on exertion of muscles and magnitude of swing.

In machines gravity is used still less than in manual work. Heavy hammers successfully are replaced with comparatively light presses. Who prevents us by any force to give masses (in the ether) speed which bodies obtain on Earth during fall?

The entire business consists in speed, which provides force of impact. Speed much more conveniently is imparted to bodies in medium without gravity than on Earth. Blow from gravity has one direction — downwards, blow from speed — where desired. This is an advantage...

Thrown bodies are more dangerous in medium without gravity. On Earth they fall to soil and become safe, in medium without gravity they rush in a straight line, until they hit somebody. But on the one hand, even on planets objects moving fast as military missiles fly for a long time before falling and stopping, on the other — vagrant bodies in dwellings of the ether, encountering their walls, lose their own speed and stop. Such bodies are more dangerous outside buildings, in the ether. But, first it is not necessary to produce these vagrant bodies without need; secondly, it is possible to be defended from them, as we are defended on Earth from bullets and nuclei.

Mechanics in medium without gravity does not differ from scientific mechanics, excluding only gravity...

Gravitation of Sun at distance of earth is not very great, namely it is 1,800 times less than terrestrial, i.e., second acceleration will be 0.0055 m, or 5.5 mm. Force which on Earth lifts 1 m, here can lift almost two versts. But from this it does not follow that removal from sun and approach to it, at small relative speeds, is confined to kilometers. The fact is that here we are talking about relative motions. A known body besides small relative speed still has planet speed relative to sun. Thanks to it and by means of it the thrown object departs from luminary and approaches it at thousands of versts, in spite of its own small relative speed...

In our medium mutual attraction of people and other similarly small bodies is observed still. But it is very weak for small objects surrounding us. However lead or platinum balls at possibly close distance from each other move like celestial bodies. Only their speed must be extremely small, otherwise they scatter in various directions in straight paths.

This gives possibility in ethereal vacuum to solve practically mass of problems not solved till now by mathematicians and extremely important people. For instance, concerning paths of motion of three bodies mutually effecting one another.

But slowness of motion and duration of observation is inconvenient with this. Thus, comparatively little ball revolves around comparatively large one, of the densest material and at the closest distance, for 2,500 sec. or 42 min. This time does not at all depend on dimensions of large sphere; be it of magnitude of sun or of a pellet — the result is the same, i.e., time of revolution always = 42 min.

For practical solution of questions about the form of motion it is necessary to remove bodies from each other, whereupon the time of observation should reach several days and months. In this there is an inconvenience. Absolute dimensions of bodies can be as small as desired. Maybe we will find more solid substances, or perhaps the coefficient of attraction of small bodies will appear larger — then observation will be limited to shorter time.

Smallness of speeds (for increase of them) will force us to use bodies of large dimensions.

In general, determinations of mutual attractions and repulsions of bodies, from no matter what causes are very convenient, in medium without gravity.

Bodies do not fall and do not have weight, but principles of inertia here especially easily are observed. Thus the larger the mass of body, the more difficult to give it motion, the larger the mass of body the stronger and longer it is necessary to give it necessary speed. Also, to stop body even greater force and time is necessary, the larger its mass and speed. Impact of moving body is the stronger, the more it is massive and hard, and the harder and more massive the body, which it strikes...

Although in ethereal dwellings density of oxygen atmosphere is ten times less than in our air, but also here motion is fast and uneconomically prolonged, i. e., requires large expenditure of work. On the contrary, outside dwellings in the vacuum

it costs almost nothing. It is necessary only once to expend work to obtain desirable speed. Then it is kept without change, if one does not go away from the sun. However, even this (as we saw) has small influence — for an expanse of thousand versts.

In vacuum it is possible to travel either in special clothes, including apparatuses for breathing, or in dwellings themselves, detached from general mass of them. The latter is much more convenient, since it gives free space, rids one of clothes, gives by its own plants food, drink, oxygen and everything necessary. Furthermore, it can be accomplished in numerous company. Even this motion will not be noticeable. It will appear to us only the motion of totality of dwellings. We conditionally consider their motion (for overcoming gravitation of Sun) zero. After all it is inconspicuous, like motion of planet for its inhabitants.

How to avoid with this dangerous collisions of vehicles or trains? There will be several main directions of motion and one speed for each direction. Trains of one direction will have one road and there cannot be collisions here. All roads of different directions are far from each other and therefore celestial ships of various speeds are not able to collide...

Laws of lever, of liquids and gases are not complicated by their weight.

Gas is dispersed infinitely, until from expansion and cooling it is turned into dust, consisting of solid, not evaporated particles.

Liquid take form of globe or bubble. Volatile quickly freeze from evaporation, and nonvolatile remain globes. These globes can be split into several smaller globes and vice versa. Adhering liquids, enveloping all objects, form odd shapes.

Sounds and in general, vibrations of various kinds spread precisely the same as on Earth. Only waves similar to sea will not be formed. For that gravity is needed. Barometer and clocks with pendulum do not work. But pocket watches act as before. Lever and spring balances are useless, since bodies are weightless. Mass neither of one nor the other can be determined. Mass is determined on centrifugal machine, or

in medium of artificial gravity by lever balance. Definition of force can be made by dynamometer or spring balances.

Magnetic, electrical and other forces act more simply and clearly, since gravity does not complicate phenomena...

Man quickly adjusts to medium without gravity, but for animals intelligence cannot suffice for this and they suffer. Nonflying insects will fruitlessly wallow in air. But, being caught by the wall, they will run, not noticing absence of gravity. Flying insects (and birds) will move, but not, as they want. They quickly will reach the walls and will grasp them with their claws. Birds and other big animals can't manage to walk, they on the first attempt, will push away from walls and will be in gaseous medium. Cats and similar creatures, with turning internal organs, can willfully revolve external part of body at least 180°.

We saw that man also can turn and move with help of support, for instance his own hat. But he can also turn without support. For this he needs, for instance, to lift hand and revolve by it just as if he turned handle of some machine. Circular motion of hand, leg or other member will also give his body rotation. But it is necessay only to stop the member, and his body will calm, although he will look in the other direction.

Here we do not consider surrounding liquid or gaseous medium, with the help of which any desirable motion can be obtained...

Man should overcome terrestrial gravity regardless of the cost and have in reserve space at least of solar system.

On Earth he is on the watch for dangers of various kinds. We no longer talk about those difficulties of life which we all experience continuously; these dangers and troubles man quickly will remove. But we talk about catastrophes which can destroy all humanity or significant part of it.

How many times, for instance, was that land on which we now live flooded with

water and at the bottom of the ocean. It is impossible to be sure that these phenomena always occur gradually. Earthquakes suddenly destroy whole cities and flood sizeable areas. Great catastrophes happened, although historical man did not yet witness them (if we do not consider the doubtful worldwide deluge). Only the more extensive the catastrophe and the more terrible, the rarer. We still can expect one.

Falling on Earth of cloud of fireballs or planetoid with diameter of some ten versts can give such a blow to Earth as to form solid, liquid or gaseous wave which will brush everything from the face of the earth — man and his buildings. The rise in temperature of atmosphere alone can burn and kill everything.

Imagine what would happen with the newly created space settlements; an asteroid with diameter of some ten km. passed through them. It can destroy only some 75 square km. of buildings and not like on Earth, i.e., some 510,000,000 square km.. In the ether it is easier to track path of planetoid and to clear it (temporarily) from living quarters and other buildings. For it costs almost nothing to move them. But how are you going to move Earth from path of some celestial body?

Let us talk about aerolites. The large ones are as dangerous in the ether, as on our planet. But since their falling on heads, homes and buildings is extremely rare and frightens no one, they also cannot frighten in the ether. From the small ones on Earth the atmosphere guards us; in it they disintegrate or burn up. In the ether dwellings can protect. Impact of tiny piece of meteor, of fraction of milligram, in passing through man can not do him any serious harm. In passing through layer of quartz glass or steel, this particle in all probability will stick. From impact particle will melt and be vaporized. Thus also will melt and vaporize insignificant part of surface of building. Impact can create in wall a very thin fused orifice. Its liquid state will immediately seal formed hole and prevent gas from passing through it.

Furthermore, it was repeatedly shown that impact of even a tiny aerolite on man is doubtful phenomenon, requiring on the average several thousand years (absence

of atmosphere on Earth is implied).

Earth, as any other celestial body, is in for an explosion from accumulation inside it of elastic matter. Time will come when humanity will be threatened by this kind of danger. Where will it flee, if it has not conquered space of solar system!

There is still another threat; the extinction and cooling of our sun. Then it will be necessary to flee the solar system. But it will be easier to flee from space than from planetary prison, holding us and all we have, by chain of terrestrial gravitation.

Overpopulation of humanity on Earth compels us also to struggle with gravity and to use space and its wealth.

Many other threatening dangers will come to humanity on its planet. They will compel people to seek paths into cosmos.

Benefits of migration we discussed much, but all cannot be discussed or imagined.

CHANGE IN RELATIVE GRAVITY ON EARTH*

Mercury

We set out for Mercury (it is clearly visible only in hot countries, we see it rarely), the planet nearest to sun, nearer to it 2 1/2 times than Earth and illuminated by it 7 times stronger.

When I moved away from lunar surface one or two hundred-versts and glanced downwards, I saw instead of it a golden cup, occupying exactly one half of sky; it was speckled with circles and notched. The other half of sky was black, strewn with stars and adorned by regal sun.

Moving in one direction, I saw how cup, the moon, occupied constantly smaller part of sky, changing into dish, plate, saucer, ordinary flat moon and, at last, into point — little star. (Picture is very similar to that on moving away from Earth).

Thus I did not lose moon from sight throughout the entire trip, together with Earth which appeared as star 13 times brighter; at the largest distance, near Mercury itself, the moon shone weaker than Venus. Constellations and Milky Way did not change their appearance and location not only on the way to Mercury, but throughout the entire planet system through Neptune inclusive, which is understandable, since entire

*Extraction from manuscript. — Ed.

planetary system, in comparison with interstellar distances, is only a point. Wherever I rushed, I was near the sun. Relative to stars I was always in one place, in spite of the fact that I flew billions of versts.

Mercury was almost in conjunction with Earth (i.e., colinear with Earth and sun) and nearest to it and therefore this time I had to rush some 100 million versts. As I approached the planet, temperature rose still higher, Sun appeared constantly wider. Rise was not in temperature of the space, which was not heated, because it had no matter (not counting infinitely rarefied cosmic ether — conductor of light) and was absolutely diathermic, but my body was heated, protected sometimes by screen. The screen also was heated and also heated me with its dark heat rays, but at sufficient distance from it — it was not too intense. Covered by screen from burning solar rays, I excellently saw stars on gloomy black background, and the glistening among them star Mercury, destination of my journey, to which I had significantly approached.

It already began to appear clearly as a tiny, horned moon, it rounded out and showed me all its phases as I circled it. The little moon becomes larger, grows before my eyes in conformity with speed of my approach, is turned into moon, similar to terrestrial, into Earth seen by us from moon, into dish, into huge silver cup occupying half of the sky... I see clouds, mountains, liquid and solid parts of planet... I am on Mercury...

This planet with density of iron (average density of Earth is equal to density of fluorspar, =5.5), is as much again nearer than Earth, i.e., 2 1/2 times. Twenty-four hour periods are the same; Sun is 7 times larger, brighter and warmer, gravity is half of terrestrial, free falling body, in first second of fall does not even cover 2 1/2 meters (approximately one sagene), average temperature is a few hundred degrees*.

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*On the bases of Stefan's law and assuming terrestrial conditions, we obtain 176°C.

All organisms transfered from Earth to this planet obviously die and decompose. But do not think therefore that there is no life. Life bubbles there vigorously, population is hundreds of times denser, more uniform and more educated than terrestrial. How is this so?..

What prevents locomotive from working at 100°C of ambient temperature, what prevents oven from heating, coal from burning, and a great number of chemical processes from being realized under such conditions? What in general prevents functioning of the most complicated machines and even organisms, if they are made of refractory substances and liquids which do not boil at this temperature? I do not know what substances enter into the composition of inhabitants of Mercury, I know even less, what kind of compounds form these substances; I know only that tissue of animals resist high Mercury temperature with the same success as our bodies resist — 20- degree heat. Temperature of their bodies, especially of big animals of Mercury, is of course, even higher than ambient temperature, due to internal processes of digestion, breathing, thinking, etc. They could easily in their hands fry our beef or cook soup. Several times, I in heat of curiosity burned myself on their soft and delicate skin. The same happened to the natives when they touched my hands or face, but they burned themselves on excessive (comparatively) cold of my body.

There are no seas or oceans of water on Mercury; water constitutes the atmosphere together with other gases and vapors. Only the upper, colder layers of the atmosphere form in nighttime and under favorable conditions clouds, which break out into intense hot rain, rarely reaching the soil. Even if small droplets of this rain reach the Earth, they immediately turn into steam, refreshing natives and soil.

Their industry and civilization stands very high, but they complain that dense atmosphere prevents fast motion of their locomotives, they complain of high gravity and impossibility of communicating with other worlds , of each of space and density of population, not knowing where to turn and long since having limited their reproduction.

With all this reasonable creatures are dissatisfied. ("At least gravity has not slighted them.") Is this merit or deficiency? Sometimes a — merit, if dissatisfaction with existing conditions expresses desire for an ideal, for better things, without disrupting love for near ones...

With what then are Mercurians dissatisfied, if gravity on their planet is one half of that on Earth? I felt excellent here (how I bore infernal heat — that is my business), ran easily, jumped three times higher and further. Their trains move 10 times faster than terrestrial; they do not have those confusions and international discords with which poor Earth suffers; there is not that gulf between types of inhabitants, one slave of the other... However, the planet is indeed very crowded — with respect to its population and its small surface. But then seas there, composed of some dense liquids unknown to me, are very small; all dry space to the very poles is settled, so that as a result their inhabited area is almost equal to that on Earth (its full surface is seven times larger).

They have strange projects in which the reasonable majority does not believe, although it treats them condescendingly. One of them, for instance, proposes by means of fast motion of masses around the planet outside its atmosphere to form rings similar to rings of Saturn, — and thus to expand territory... In order to start these rings, speed near 2 versts per second (2 1/4 km.); is needed at the surface of the planet while their fastest trains (pointed like ships for cutting the atmosphere) pass over not more than 300 m per second, what is insufficient. However, planners suggest various means to decrease friction and to increase speed to magnitude necessary for elimination of relative gravity, they also suggest methods for comfortable living...*...naval paths and using them even more than air, especially for transport of cheap cargo. Aviation machines (birdlike — with wings) also are in wide operation; but they are used by richer people or government, because such a method

*Omission in manuscript of about two pages. —Ed.

of communication (the fastest) is beyond the means of the average man. It is true that, Venutians have not reached the civilization of Mercury, but then none of them is carried away and none constructs such impossible plans, which are the weakness of Mercury. I repeat, our good neighbor is nearer to Earth even figuratively; and if a dreamer appeared there with proposal to expand territory by means of rings revolving around the planet, similar to those of Saturn, then they, not procrastinating a minute, would conceal him in insane asylum, moreover with a most humane purpose.

Farewell to Venus, like Earth, splendid adornment of its evening and morning sky.

Mars

Mars is two times further from sun than Venus and 1 1/2 times further than Earth. Quantity of heat obtained by a certain unit of land measure of soil of Mars, is two times less than one of Earth with same conditions. It is natural that the mean temperature of Mars should be much less than on Earth; it is in fact so. Its mean temperature is 32° of cold on Celsius. (Reasoning about temperatures; maximum +83° C ...) We do not reason, however, thus; absolute temperature of planet, i.e., starting from 273° of cold (absolute zero), is proportional to intensity of sunlight and heat, or visible surface of radiant luminary. Then, taking terrestrial absolute temperature of degrees as 300°, we would find approximately; for Mercury -- 2100°, or 1900 Celsius, for Venus -- 600 or 300 ordinary degrees, for Mars -- 130°, or 130° of cold, and so forth. There is nothing of the sort, as we partly saw, temperature is much more moderate, even on Mars there cannot be such continuous cold. Actually, even on Earth in winter the sun shines on our planet 1/15 more intensely (thanks to location of Earth at the nearest distance from sun). If we allow preceding reasoning, then mean temperature of Earth in our winter would be raised 18° C. Is this observed? Is average increase even of 1° C observed?

Waters of Mars in unremembered time, when sun still shone brighter and was larger and when the planet itself with its surface was still hot, occupied lowest part of

land, like our terrestrial seas; in this position they petrified, constituting hard part of crust when times changed and temperature dropped.

But solar rays of equatorial countries of Mars striking these ices, melted them a little bit from the surface, made it glossy and turned it into steam; the steam, rushing into the atmosphere in insignificant quantity made beginning of snow clouds, which settled at night in polar countries of planet in the form of brilliant layer; sometimes planet simply was covered (like terrestrial pole) with white hoarfrost. It precipitated on dry land directly from atmosphere from its contact with extraordinarily cooled parts of the planet.

And these petrified seas and branches ("canals" of Mars) are comparatively few.

Thus, planet represents from the surface one solid mass, if do not consider ice slightly moistened and extremely contaminated by dust, which gives beginning of pitiful streams, immediately after setting of sun freezing and becoming covered with white hoarfrost. Entire planet at night is covered with it, but night parts of planet are not visible to terrestrial astronomers; on day parts, besides polar, it melts soon after rise; ice and land lose snowy appearance and seem seas or ordinary land.

Glaciers and ice oceans are exploited by Martians as means of communication, since these paths are the most horizontal.

Planet is much smaller than Earth and somewhat larger than Mercury; gravity is 2 1/2 times less than terrestrial; twenty-four hour periods are the same*, but year is two times longer. Nights are illuminated by two moons; they are both small and weak and have value only thanks to proximity to planet; the nearest — Phobos— shines eight times weaker than our terrestrial moon, visible diameter is two times less (than our moon). But then Phobos completes its course along celestial vault very fast, faster than sun and therefore every 12 hours sets in the east and ascends in the west. The other satellite moves usually, but slowly, so that it appears from

*Question is still controversial.

behind the horizon only every five twenty-four hour periods (approximately).

Inhabitants, i.e., Martians, are very dear, but they dealt with me very cautiously, fearing to burn themselves. If on Mercury and Venus they used me as a refrigerator, here they used me as a good heating stove. They caressed me terribly; indeed, into every house I brought heat. I am speaking, it is understood, about the winter of moderate countries; in the summer in spite of the frost, which we rarely meet, they panted and sweated from "heat" some special extraordinarily volatile liquids. In this unfavorable time for me I decided to slip away from them in a delicate manner.

Vesta

Beyond Mars is the Asteroid Belt, they think fragments of one great planet, existing once between the orbits of Mars and Jupiter, according to the law of Bode. However, I personally consider such a hypothesis for many reasons hardly probable.

Thus, we will bid farewell to Mars and its satellites and fly beyond its orbit. Now beyond it we encounter a mass of small planetoids, but not saying anything about them now, we will head directly to the biggest of them, to their tsarina — Vesta.

It is 2 1/3 times further from sun than Earth, and the voltage of its rays, flooding the surface of Vesta, is 5 1/2 times less than on Earth.

Diameter of sun seems over two times narrower and its surface five times less than from Earth, it shines and heats as many times weaker.

In spite of low mean temperature, the inhabitants of this asteroid are similar to lunar inhabitants, but made of materials of which do not freeze and are elastic. They do not suffer from cold at all and live in clover. Understand however, that the latter expression is not literal, because the absence of atmosphere does not allow them to be occupied with vocal exercises...

They have almost no plants and animals, besides places of science, where they carefully are collected in special environment and serve as subject of experiments and study.

Intelligent population, covered with transparent skin, (admitting light but not releasing matter) lives very long and gives birth rarely. Young generation is educated in special buildings, closed on all sides, not admitting gases and liquids but admitting light. In a word, in the first period of life Vestites are developed and grow approximately like inhabitants of Earth or moon with the only difference that their medium is purely artificial and in their feeding sunlight plays a significant role.

But when they reach normal growth in their nurseries and their skin hardens, and sweat glands, light organs and others unnecessary in vacuum are closed or are atrophied, they emerge to freedom with their own emerald wings, like butterflies from cocoons. Further, in the entire continuation of subsequent happy life, they are changed only internally, their thoughts are changed, gradually improving and attaining truth, while in their bodies, externally constant, eternal animal vegetable rotation is accomplished, which was described by us earlier (Moon).

Gravity on Vesta is 30 times weaker than terrestrial, because the planet itself is very small and with respect to terrestrial amounts to the same as millet grain (2 mm) with respect to apple (60 mm). This is why gases are stored here only in hermetically sealed locations or in chemical bond with nonvolatile liquids and solid substances; small gravity is not able to restrain swift motion of gas particles, which are dispersed into infinite space, leaving nothing around planet; while on the moon they are accumulated in its deep cracks, which serve as natural nurseries of growing generations.

Thanks to small gravity, a one pood measure pulls almost like a one pound weight. Weight of man produces impression of weight of chicken; green wings of natives rush by them like fluff; their comparatively large surface give them much solar energy, in spite of the small intensity of rays. This energy makes their motions extraordinarily light, but thoughts, on the contrary, are very deep. However, ease of motions occurs also from weak gravity.

Do you know, that when I got here I thought that here there was no gravity at all - I felt free; here the expression is justified, "An extremely fast run creating a sensation of flying." If someone weighed me, a four pood healthy fellow, on spring balances, then not more than 5 1/3 pounds would be obtained. After Mars, where gravity nevertheless is 15 times more, this seemed to me very easy... My jumps lifted me vertically to altitude of 20 sajenes (40 m), i.e., to altitude of sizeable belfries (of which unfortunately there are none): horizontal jumps transferred me through ditch 80 sajenes in width, and much larger, if I got warmed up; but also without any exertion striking results were obtained.

Inhabitants of this planet, experiencing the same ease of motion and not experiencing resistance of air while running, have long and seriously been planning to expand their own possessions, hurrying into space with the help of speed or forming around planet moving rings and such. Listening to their arguments, I no longer was surprised by such ideas, which were preached even on Mercury. Really, if not now, then maybe in the near future they will reach their goals.

The essence consists in insignificant gravity; our terrestrial gun shell launched, from surface of Vesta, so to speak, pierces the "crust" of its gravitation and flies away from planet forever, in order to be made satellite of sun, a newly formed planet. If ...* on sun, it would move away from it always and in one direction.

Trains of Mercurians, passing through 300 meters per second (near 1000 versts per hour), placed on smoothed equatorial path of Vesta, due to centrifugal force not only lost weight, i.e., not only ceased pressing on tracks, but also burst upwards — into surrounding free space, to conquer which the inhabitants of this insignificant planet apparently so thirst. Such fast trains are all the more possible here, that friction is lightened 30 times and atmosphere "glitters by its complete absence". Gases needed by inhabitants for training of young generation are obtained by them

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*Omission of several words. —Ed.

not from the atmosphere, but from the solid soil; Vestians decompose chemical ores and other oxides and obtain thus oxygen, nitrogen, etc., (with the participation of the sun). However, they hold gases most frequently by weak combination with other substances, these compounds, being ordinarily liquid or solid, during light excitation (for instance, during heating) yield their gas to whom or what needs it.

Thus here trains of Vestians do not compare in speed with trains of inhabitants of Mercury; but also available speeds of these trains are sufficient in order to very noticeably (almost half) decrease their weight.

How Mercurians would be struck if one told them that their trains, brought into action on Vesta, would attain their "high" goal, to exploit and to colonize space lost to no purpose, and escaping energy of solar rays to no purpose. It seems to me, hearing about this, they would double their own efforts, achieving success. Probably, even Martians would become agitated, never having considered anything similar.

But, it is asked, how do inhabitants of Vesta set in motion their mechanisms, for instance, trains? Why not by their own muscles? Oh, of course, of course... They have solar motors, as do all reasonable creatures living in gasless space. Essence of them consists in the following: imagine a thin impenetrable vessel varying its own volume like harmonica or bellows; such cylinders even here are made of metal and it is even thought to replace cylinders of steam engines with them. They were hermetic and reminiscent of Chinese lantern folded up into thin circle. In similar vessel a certain quantity of suitable gas or vapor was contained, which expanded and opened walls of vessel when it was exposed black half to the sun, then was compressed if it was placed behind screens in a shadow, losing heat and obtaining very little in exchange. Thus, walls of vessel under simple conditions first shifted, then were opened, like concertina in hands of someone playing it. This could serve as source of fairly significant mechanical work. Simple turning of vessel (accomplished by itself) by inertia (after impetus) first of black, then of brilliant side to light should already give work.

I described the simplest type of solar motors, the least massive. There was also another kind of motor; gas or liquid heated by solar rays directly or with the help of reflectors (i.e., mirrors) was distilled from one vessel into another, standing in the shade and therefore extremely cooled. With this distillation the gas or steam passing through steam motor accomplished work. Such machines are more complicated and more massive, but more economical, because from given area illuminated by rays of sun, great work was extracted. There are systems still more complicated. In such systems not one drop of liquid and gas is lost, and if losses occur, then only at random or extremely little.

To what extent these motors can be strong, judge by this; ideal work of solar rays at distance of Earth, exerted on 1 square m normal to rays and assimilable without losses by machines amounts to 2120 kg-m, i.e., on square arshin around 1 1/2 horsepower is necessary, or 15 strong men working continuously — day and night. But since intensity of solar rays at distance of Vesta is 5 times less and, furthermore motors transform not more than 1/3 of intensity of rays into mechanical work, then square arshin occupied by motor corresponds to work of one healthy fellow working untiringly (0.1 horsepower or continuous vertical ascent of man on stairs with speed of 1/4 arshin per 2 seconds).

Properly the muscular expenditure of inhabitants of Vesta is extremely small in view of the small gravity, which does not develop their musculature. Nevertheless work was accomplished by described motors, which set into action working machines, very various in assignment and complexity.

Inhabitants of Vesta, placed on our clumsy Earth, would be immediately destroyed by its gravity, which would happen also to us if we were placed on sun, where gravity is almost as many times stronger than terrestrial as the latter is stronger than gravity on Vesta. It would rupture blood vessels of thin-legged Vestians, and they of course could not bear it; their wings would droop, feebly descend, and their body would collapse on Earth and be broken into pieces, as if excessive load were piled

on them.

But then I, after terrible chains of terrestrial gravity, not spoiled by its tenderness, felt here "on altitude of vocation" and surprised my masters by amazing acrobatic feats.

Put me now on my native land, and I would be terribly disillusioned with it, feeling like an earth worm.

Vesta is little eccentric and therefore its temperature in the course of a year is fairly constant. Time of rotation is twenty-four hours, as for Earth; therefore speed of equatorial points is not so little that it was possible conveniently to follow sun and to transform evening into morning and vice versa, in a word, to govern at times the day (like on the moon). The biggest speed, stopping (apparently) the twenty-four hour course of the sun and making day or night eternal, amounts to around 15 meters per second or 1333 km (1230 versts) in twenty-four hour period. Vestians can run at this speed, but with such exertion of forces that is not quite convenient to use. But then in trains moving much faster you encounter miracles at every step. For instance, you awake early in the morning, sit in railroad car and hasten to set out; but here - alas the joyful sun, just now rising, in two, three hours starts to set... What can be more charming than morning freshness, which you planned to enjoy and instead of which you got night...

Or else it happens thus if you ride on the opposite side; you sat on train in the evening, planning to admire sunset and then read and snooze in night silence, but suddenly capricious sun instead of setting rises higher and higher. You are in desperation; it does not let you sleep and disrupts all your innocent plans. But sun is inexorable; noon and evening comes, lost time as if returns, sun sets, you rub eyes and do not believe them, probe yourself for head sick from sleeplessness and disillusioned, fall into dead sleep...

But imagine terror of traveller departing at night on a path around the equator westward at a speed of 54 km per hour and seeing motionless celestial vault... 100,

200, 1000 hours pass and not one star sets and sun does not rise, dawn doesn't come and doesn't even intend to come. Let us note that there is no ordinary dawn from air on Vesta; there is dawn of a special kind; partly zodiacal light, partly consecutive reflection and glow of raised and illuminated parts of surface of planet. It is unpleasant also when you depart at noon and immobile sun bakes you inexorably ... never ceasing... It is possible to lose one's mind...

Population of planet is very thick and little less than terrestrial, in spite of diameter 30 times smaller and surface 900 times smaller; for each creature thus is necessary an area of planet of 370 square m, or 80 square sajenes, i.e., for 30 men — around 1 dessiatine.

Regarding the volume, we can judge it by the fact that from the mass of our planet can be rolled 27,000 such spheres as Vesta. Mountains in general are smoothed on it for the sake of convenience of communication, but in chronicles of inhabitants data were kept about mountains 100 versts in altitude, so that it was impossible to say about this planet that it (at least from a distance) was reminiscent of a polished ball or globe. Actually, such hundred verst unevenness amounted to 1/4 of diameter of planet and made it more similar to a stone (fragment) than to a sphere. Calculations show that relative elevations of planet under identical conditions are proportional to square of decrease of its diameter. And since diameter of Vesta is thirty times less than diameter of Earth, then the biggest mountains of the first can be relatively higher (900 times); altitude of mountains of Earth comprises not more than 1/1200 of diameter, hence altitude of mountains of Vesta will be 900/1200, or 3/4 of diameter.

However, unevennesses of such small planets can be still larger due to decrease of force of their gravity with distance.

Ceres and Pallas

But we will abandon dear and hospitable planet with its highly educated inhabitants, dreaming sometime of breaking through the gravity of their own planet and

rushing with a mighty stream into infinite space outside the pitiful surface of their planet, in order there to spread their own rule over nature. We will abandon the kind dreamers and fly further.

On the journey, roaming in the diffuseness between asteroids I thought; whence did these creatures appear? Their existence would be clear on the moon, where there was atmosphere before, whose gradual rarefaction in the course of tens of thousands of years their bodies could adjust to and manage without atmosphere. But whence these inhabitants of Vesta, on which, obviously, by its smallness there could never be gases, because particles of them have speed of at least gun shells, and like the latter would, overcoming weak gravity, be dispersed into surrounding free space... I felt sorry that I did not talk thoroughly with Vestians about the origin of their ancestors. However I did not want to return, the more so because distance strongly beckoned me...

Beyond the hugest planetoid — Vesta — followed in magnitude two planets — Ceres and Pallas. Their average distances from sun differed very little, but plane of orbits did not coincide and the orbits themselves, understandably, did not cross because otherwise (although in several thousand years) their collision would be inevitable.

Average distance of these asteroids from sun is 3 times (2.76 and 2.77) greater than of Earth to the same luminary; the diameter of sun seemed many times again less from them, the intensity of its light, heat and gravitation was eight times less than action on Earth.

Ceres is somewhat nearer to the sun than Pallas, and somewhat less than Vesta; namely the diameter of Ceres is only 63 versts less than diameter of Vesta, i.e., 1/6, 1/7 of it; but Pallas is incomparably more eccentric, in consequence of which the visible diameter of sun oscillates during its annual motion (i.e., during full turn around luminary) very strongly -- from 1 to 1.7, and thermal force -- from 1 to 3. Furthermore, this planet was on my way, while Ceres was on opposite side of the orbit and I had to make a detour of almost a billion dilometers in order to visit it.

Pallas significantly differs from Ceres in magnitude; it has diameter of only 255 km, i.e., almost twice less than Vesta, also gravity on Pallas is 52 times less than terrestrial.

All these considerations forced me to hurry to Pallas But until arrival I noted with my naked eyes around it what seemed a huge altitude of atmosphere. Here I remembered the observation of Shreter, who also saw atmosphere on Ceres and Pallas and found its altitude three times more than diameter of corresponding planet.

Relative to Pallas the fact was confirmed and made me sorry that I could not check observation of astronomer also concerning Ceres.

Atmosphere was strongly X-rayed, not at all distorting and not refracting rays of stars passing through it; this seemed strange to me, as also in general the existence of this "exceptionally high" atmosphere.

There is still a moment — and I am near to it that I clearly realize my own error; this is not atmosphere, but simply a ring like the ring of Saturn, only reaching the very surface of the planet, flying aside and glancing at it from the side, I am still more convinced of my own error. Indeed, the ring seemed elliptical and even a thread, which could not be with atmosphere. It is known that the ring of Saturn also during its own solar turn, i.e., in 30 terrestrial years, twice seems a thread, because twice its plane stands in direction of beam of sight of terrestrial astronomer, i.e., coincides with orbit of Earth.

Transparency of ring of Pallas was explained during my actual entry into its area; it turned out that it consists of a huge number of bodies flying around the planet. These were natives of Pallas, their dwellings, motors, factories and various instruments. Placed freely, in order not to take away rays of Sun from each other, they left opening like gap of net. From afar one cannot see separate objects, but only their transparent totality is conspicuous, producing illusion of gas or rapidly turning wheel. Let us note that some of the rings of Saturn are also transparent, but the cause of this is unknown.

Flying rapidly past dwellings of infinite colonists and not considering anything carefully, I directly stepped on solid soil of Pallas itself.

After Vesta here it turned out to be still easier; my weight on terrestrial spring balance showed three pounds. On gravelly path, studded with sharp stones, I could go barefoot without harm, I could lie on stones just as calmly as on the most delicate feather bed. I jumped two times higher and further than on Vesta, presenting among comparatively weak inhabitants a somewhat comical picture of a jumping flea. However, for natives this spectacle was very consoling. Each of my jumps was accompanied by applause and continued half a minute and more, because I was lifted very high. During flight I succeeded in blowing my nose, asking about time and even thinking in order. Each time when I needed "from birdseye view" to inspect buildings of natives, their different constructions, paths of communication, and so forth, I jumped, and "from the highest point of view" obtained general idea about desirable things, being lifted 20 - 30 sajenes vertically, I there was as if stopped, in order for several seconds to obtain noticeable speed downwards.

I do not describe natives, because they are strikingly similar to Vestians, and little distinctions escaped me, like the distinction between butterflies of one species (of one "type"). I will say that their bodies, supplied with emerald wings, were elegant, like precious malachite vases, that their eyes shone like diamonds; I repeat that they were fed by solar rays like plants, and were innocent like flowers. When I called them children of the sun, they expressed bewilderment and said "the sun itself is drop of wisdom".

Mostly their "rings" interested me and their life in that place, outside the planet. I wanted to know how they managed to form these obviously artificial rings, and how they arrived at such an idea.

I exchanged thoughts with them by means of pictures, drawings and gestures, they by the same methods, but mainly with the help of natural pictures, sketched with polychromatic subcutaneous liquids on their transparent chest skin. It is clear

that their brain, their thoughts were connected by vasomotor (vascular motor) nerves with influx and ebb of these liquids. Such an omnipresent and main "language" was encountered by me everywhere where there are no atmospheres and air sound waves. This language is the same everywhere, because it depicts the real nature of objects and phenomena, constituting their certain similarity; the talking organ of natives, as we see, is very complicated and I could not argue with them with the speed and accuracy of their transmission of ideas. I understood them better than they me; who will not understand an excellent artistic picture, which instantly appears on their chest, instantly disappears and is replaced by a new, still more intelligible one or a component continuation of the second. You can see something similar in moving and colored light images of camera obscura (or of photographic apparatus)*.

Chest pictures of Pallasites changed as rapidly as their thoughts, like images of fantasy; eyes served them instead of ears.

On Rings of Pallas

Inspecting the surface of Pallas, we turned to the most remarkable thing — to its disk, to its small circle, whose center was occupied by the planet.

For the inhabitants of Pallas it was much handier to execute the dreams of Vestians, to colonize space surrounding the planet. Really, the struggle with gravity here comparatively is not labor, speed of 200 m per second is enough so that body moves away from surface of planet forever and is made a satellite of sun, i.e., an independent planet. For train it is enough to have a second speed of 141 m in order to finally lose weight and obtain movement in surrounding vacuum; such a train, passing 508 versts per hour, moves only four times faster than the fastest terrestrial trains. This speed and even greater here is fully attainable, because gravity is 52 times less than on Earth. Friction of all kinds is as many times less, so that speed, with identical expenditure of energy, can be boldly increased (comparatively with speed of terrestrial trains) four times. And if we still consider the absence

*There was still no cinema when I wrote this.

of air resistance, perfection of means and technology of Pallasited, then it can be increased 5 and 10 times, but this is already unnecessary; fourfold acceleration is enough.

Only do not think that directly on the equator of the planet you will see a running 500 versts per hour and thus running around its circumference in 1 hr., 35 min.. No, the first train, standing directly or moving on the very surface of the planet, runs 14 m per second (50 versts per hour). It winds around the planet in a continuous ring and moves around it, like a worm around a nut. Second train, like the first, but running on it, like on moving platform with moving rails, passes as much again relative to it; but relative to the planet it has speed two times larger, i.e., passes through around 100 versts per hour, or per second — around 28 m.

With the same speed and in the same direction the third train moves on the second; relative to it it passes through 14 m in 1 second, but relative to the planet its speed will be trebled (150 versts in 1 hour). Thus each highest train on the preceding passes through 50 versts per hour, but the speed of this highest train relative to the planet depends on the floor. For instance, train of 5-th floor passes through 250 versts per hour. Last train — 10-th, moving on ninth (representing like all the trains, a continuous ring with platform and rails), passes through already 141 m per second. Due to centrifugal force gravity inside it and relative to it absolutely disappears; it hardly touches its path and it does not press it at all. Following ring, the 11th can be held in space without the least support and contact with the 10th train, although the speed of the 11th train and all following after it not only is not increased relative to the planet, but even somewhat decreases. The hour speed of the 10th train per 508 versts is the greatest speed of the entire compound ring or circle, reaching to altitude of 800 km. (versts). Further, speed of rings is continuous, but decreases extraordinarily slowly, so that the difference of speeds of two neighboring trains is imperceptible. In other words they move almost with identical speed. Outskirts "little circle", i.e., the last highest train, passes through only 53 meters in 1 second: this means, that its speed

is almost (2.64) 3 times less than the fastest.

Having described briefly the essence "multistory" trains and the secret of existence and formation of the ring of Pallas, lets climb on the first train, which is very easy to do, for this we will run level with it (50 km per hour is a trifle on a planet where gravity is 52 times less and resistance of air, very noticeable on Earth with such a speed, is lacking). Doing this, we need only while running to stretch a hand, grab the attachments — and the matter is finished; the maneuver is identical with that which you use when running you jump on horsecar.

Gravity here (on the 1st train) is less than on the planet, which although it is felt, easily can be detected by spring balances taken with you. The same can be noted by delayed movement of wall clocks with pendulum; for that we will synchronize them with indication of pocket watches, whose action does not depend on gravity, and only on elasticity of steel spring ("hair"). Decrease of gravity in general on the first train is not remarkable and does not come to our notice, after what we experienced in this respect, but it progressively increases with transition from train to train. If one were to take decrease of gravity in first ring as unity, then in second it will be 4, in the 3rd —9, in 4th —16, in 10th —100. In following trains it is also 100.

From first train in the above-described manner we get on the second; however, let us note that it is possible to use for this also individual devices, which transfer you inconspicuously and without any efforts to any train. I will not describe them, however, in order not to wear out your attention the majority of natives use them.

With move to the fastest, 10-th train, standing very near the surface of Pallas (10 sajenes or so) gravity apparently absolutely disappears: pendulum quite ceases to swing, weights do not strain spring balances, i.e., show zero, — bodies do not fall... I hung among the railroad cars like a fish in water or like a bird in air, but, understandably, without any effort. Ideas about up and down were mixed in my

brain and depended on direction taken by me; above my head seemed up, under legs down (where I, however, did not fall, which confused my senses). I had only to turn my legs to ceiling of railroad car — and all in it or, it is better to say in my head, turned "top to bottom", floor of railroad car seemed ceiling, and ceiling — floor, and it was difficult for me to convince my senses that railroad car had not overturned. I did not sense its motion because it was extraordinarily calm, like motion of boat; how they achieved this, I cannot explain to you. Glancing in window I saw, as soil of planet went away to the side, opposite my own course (inconspicuous to me), each one and a half hours sun ascended and inspected parts of planet returned.

The most insignificant impetus is sufficient to fly in railroad car or outside it in desirable direction; it is enough even to sneeze, yawn or cough, so that my body, till now motionless and touching other objects without pressure obtained speed forward and very long — in a straight line. With this to straight tendency in large part rotary is added and then it seems to you that soil of planet with its own train and celestial vault with stars and sun turn around you.

Slightly pushing the wall of the railroad car, I flew to the opposite door, but was frightened and grabbed the column of porch; thus I held some time, looking around on all sides and calming myself. No. It is terrible for me to fly away from this ring. And I attached myself to column by long and thin twine; then I weakly pushed away from it and flew several seconds strictly in a straight line; only twine kept me from a further jaunt, and where would I have flown? God knows... Twine strained and gave me reverse impetus, which returned me unharmed to railroad car. Rebounding from it a second time, already involuntarily like a thrown ball (since I did not intend to repeat the experiment) and again flying only slowly the distance of the twine, I remained almost quite motionless.

Under me planet rushed fast, on which I did not fall, in spite of the force of its gravitation; before me rushed pictures of planet life, various constructions, excellent palace dwellings and rows of thick population of Pallas. Many of them

climbed aboard the train, passing from one to another; others descended to planet. My train and highest rings seemed motionless, lower ran together with planet and the faster, the nearer we were to it; in fact it was just the opposite.

Upper rings swarmed with life and represented a miracle hanging in space; they touched one another only with certain parts, leaving large gaps.

I pulled on twine and with the obtained impetus returned to railroad car; in order to be lifted upwards from it ten or so versts, a jump is sufficient; so I, disentangling myself, got on higher rings; flying a respectable distance and stopping at one of rings, I made a new jump and again flew versts without any effort.

Area of entire disk was 48 times larger than surface of equatorial section of planet. Thus, taking into account that the plane is not always perpendicular to rays of sun, we will find that inhabitants of Pallas captured 20 times more heat and light than it was assumed for them by magnitude of their planet. Diameter of latter was seven times less than width of ring, this means it was comparatively larger than for Saturn.

All bodies, carefully released without impetus on rings higher than 10-th do not fall anywhere. If, however, they are given an impetus, they fly (relative to rings) fairly long, in a straight line and evenly, where they were pushed. It is possible to move the released in the direction of planet, but this is dangerous, because it with terrible force will strike against first object projecting on it. We can throw and send anything in other directions; it will move upwards, downwards, sideways — absolutely indifferently and freely, although with the passage of time it will nevertheless come back to the rings. Hence it is clear that this motion is curvilinear and not completely uniform (even relative to rings). However at distance of versts and for minutes, even hours it does not differ at all from motion of bodies in a medium deprived of gravity. On the entire 800-verst extent upwards from surface of Pallas, ring represents relative medium of full absence of gravity (if we do not consider natural, insignificant force of its gravitation), but also it is almost

absent in the gaps between rings (attraction of lower rings is destroyed by attraction of upper). This space relatively free from gravity, in its own beneficial properties does not differ at all from a medium absolutely deprived of gravity (which in essence is lacking). It is necessary, for instance, to push away horizontally on thin line of one of rings, and you with one weak effort start to move with speed "of mail horses" relative to the ring, on the side of it or in their intervals; you move all your life, pass through millions of versts and cannot stop if you do not use corresponding measures. Your motion relative to the planet, of course, is 100 times faster and exists eternally, besides you, thanks to circular motion of rings. All possible meetings and intercourse of inhabitants of disk are accomplished with great convenience and without least work; they do not at all need such comparatively powerful instruments or movement as our legs... Participating in their meetings, jaunts, occupying myself at the same time by reading, or by business and hardly noticing roads and my own motion, not feeling headache and fractures in bones from shaking and dust, I involuntarily turn mental glance there — to my native land, to Earth... I see there unfortunate traveler, rubbing his bloody corns, in order to go 2 - 3 tens of versts, I see also man with abundance in his own carriage, by rain, chilled, dreaming about rest and soft bed; but what is such a bed in comparison with "bed" of free space, which you never abandon there... My heart is overflowing with pity...

—How did this thought occur to you; to conquer space and solar energy by such simple and easy means? —I once asked the inhabitants of Pallas. Then they told me the following.

Long ago, in old times, their planet was far from so smooth and spherical as now. On the very equator there was a mountain, revolving together with the planet. On this mountain, with altitude up to 800 versts, we were lifted vertically as freely as you are lifted on Earth on inconspicuous slope of 1/2 degree; your every jump would lift you 30 m in altitude (14 sajenes) upwards, during 1/2 minute of flight,

so that in 1 second you would go 1 m (speed of pedestrian).

We with our own weak legs did not make such jumps, and directly we were lifted with speed of 3 - 4 versts per hour; the entire way, consequently perhaps is passed in 200 hours or 8 terrestrial twenty-four hour periods, but considering rest -- in two weeks. Then mechanical roads were arranged with solar motors and journey to summit of mountain no longer amounted to any effort.

But the point is not that travellers ascending the mountain by one or another method constantly noticed themselves lighter the higher they were lifted, their jumps were the freer and the more grandiose, the more their range was raised. At altitude of 700 versts very heavy objects weighed less than valve and, like fluff, with each impetus they were raised several versts, for a long time flying and slowly dropping; at distance of 750 km. gravity finally disappeared. Jumping aside or simply not holding the mountain, you are separated from it and hang above the planet at an altitude of 750 km., having abyss above head and abyss under legs...

Imagine the position of a reasonable creature, somehow accidentally torn away from mountain and losing it from view more and more. He wants to return to it, stretches helplessly his hand, pitifully appeals, but it is all in vain, the mountain continues to go away.

It is good, when there is any support, it is good if you go away from it accidentally together with fragment of cliff. Then, pushing it aside opposite to your motion, you still can return immediately from this abyss swallowing you up. And if there is nothing?.. But be calm. The first traveller who risked so terribly did not perish, and even completely safely returned to his own near ones; he only made a cheap round-the-world journey, indeed, so far from Pallas that it seemed to him a brightly shining gigantic moon, occupying a huge part of celestial vault (15°, 900 times more than our terrestrial Moon).

Where, however, did he return? He returned to that mountain in two terrestrial months, assuming weak pushing away, giving him relative forward velocity of around

one meter per second.

After the first traveller, who returned in great fear, but at the same time also with great joy, a mass of daredevils followed, quickly forming with their own rubble a whole living ring around the planet. Crowdedness on planet, deficiency of sunlight, i.e., their food chased away people of the kindest, wishing to avoid quarrels and troubles because of piece of bread (this is - terrestrial, and in our opinion — because of solar rays).

Quickly they noted that extremely high mountain hinders formation of rings from above and from below. Education spread, mechanics and technology went forward, and finally they devised what you now find we have; mountain was razed, as producing by its own gravitation "perturbation" in rings and preventing their free motion and growth upwards and downwards.

And now we are increasing the diameter of our ring as needed, — added the narrator.

LIVING CREATURES IN SPACE*

From a narrow terrestrial point of view animal life consists of 29 known elements. Its main component is water; it can bear temperatures no higher than 100°C. and no lower than 100°-200° [sic]; otherwise in this state it cannot live (insensibility, or anabiosis), and is only preserved; the majority require a definite mean temperature, close to 20°C. Animal life requires atmosphere containing oxygen and water vapor. Source of its activity, i.e., motion and thought — other organisms or, in extreme cases, Sun (animal-plants, or zoophytes). Apparently, animal life cannot exist without atmospheric pressure and without gravity. Its body should have a temperature higher than point of freezing and no greater than 37-40°C. Mature animal life has a definite growth [limit].

Even the highest animal (man) are not perfect. For instance, the life span is short, the brain is small and poorly constructed, etc.

In essence all this is only the result of orientation to conditions of life on Earth — mainly to life on the equator — and criterion of incomplete phylogenetic

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*Article gives a broad view of overall propagation of life in space, on its variety, indicates worlds in the universe, on periodicity and complexity of matter and phenomena — without end, the existence of infinitely remote epochs, when there were "ether" animals not similar to terrestrial and difficult to imagine, although complete and conscious.

development (evolution). On other planets, with other conditions, also the structure of animal life will be different. The Earth also will give best with the flow of time. We will sort out in order all data about terrestrial organisms.

Why is animal life composed of 29 elements, why do the other 61 elements — for instance, gold, platinum, and others, — not enter into its composition? And even if they do enter, only accidentally, in insignificant quantity, not playing any role? (And even if these 29, probably, 9 are not needed.)

First cause is in the fact that animal life is fed by plants, and plants contain exactly these substances. Why are plants composed of these substances? Plants are surrounded by atmosphere, water, and vapor; they shoot their roots into soil. Therefore, they also have to contain these substances. Namely, water gives plants hydrogen and oxygen. Soil, being dissolved in water, mostly gives plants calcium, phosphorus, chlorine, sulfur, sodium, heat, fluorine, magnesium, iron, silicon, manganese, aluminum, etc. Atmosphere gives oxygen, carbon, and nitrogen. In insignificant quantities soil and its water contain also other elements, but their quantity is small, because these are rare substances or they are heavy and hidden in the bowels of earth and, therefore, less available to plants. If on the surface of Earth and in atmosphere there predominated other elements, then also the composition of animals life and plants would be different.

On the surface of plants close to suns there are more heavy elements and, therefore, there into the composition of organisms there should enter heavy elements. Conversely, on planets remote from suns would enter organisms would include lighter substances, since there are more of them.

Man obtained heavy metals from bowels of earth and made, for instance gold, a part of his body (teeth, etc.). In general, the composition of animal life also on Earth still can be changed.

What will the conclusion be? All substances are needed for creation of organisms, in suitable conditions. One must think that on each planet, consistent with

substances of its surface, distance from its Sun, the properties of the latter, the temperature of planet and other conditions, there would predominate in organisms the most varied substances.

Animal life consists of solid bodies and liquids. But, after all, water is not the only liquid. Conversely, on planets remote from the Sun — in general, at low temperatures — water is a mineral, and the predominant liquid substances have another composition; for instance, liquid carbon dioxide, various oils, alcohols, hydrocarbons, carbohydrates, liquid gases, etc. They also would enter into composition of seas and organisms. Also on planets close to Suns our solids would be liquid and could enter into composition of animal life.

Atmosphere of other planets could also have a different composition. On cold planets there would predominate hydrogen, on planets close to suns — steam or other liquids, turned into gases by the heat.

From this we will make a new conclusion: on cold and on hot planets there are possible creatures composed out of those seas, atmospheres, and soils which exist on the planets.

It is true that for abundant development of life there is needed temperature of medium fluctuating near $25^{\circ}C$. We saw that neither high nor low temperatures deprive planet of oceans and atmospheres - they only mean different composition and, consequently, do not prohibit also animals. The latter will be composed of liquids and gases suitable to the average temperature of the given planet. This means that the most varied temperature of planets does not prevent richly developed life on them.

We see that even our organisms adjust to low temperature. But, of course, these are the most imperfect creatures or reasoning man, knowing how to defend himself from cold by artifical means, which cost him terrible efforts. But after all, the northern animals moved from warm countries, their native land — the equator; they are not adjusted to severe climate. Only in hundred of thousands of years could

this have been done — besides not many of them made it. Therefore, we still see no splendid flowering of life in winter conditions and polar climate. However, main cause of poverty of cold countries is the absence of solar energy.

Temperature of body of highest creatures of Earth is close to 37°C. Why is this so? Native land of life is the equator. In its waters life began. (The cause — uniform heat and abundance of solar energy.) There the average temperature of water oscillates around 25°C. And this is the temperature of first animals, the height of whose life, its bright manifestations corresponded to just this temperature. Animal took temperature of environment, accepted also low and high temperature, but felt well only at the mean temperature of environment.

Due to weak energy of life of first creatures, their temperature was only somewhat higher than the temperature of environment.

But there appeared warm-blooded ones with mighty manifestations of life. Due to this (heat, burning, or chemical processes inside animal life) temperature of their body was strongly increased in comparison with average temperature of environment. Thus, temperature of animal life is always somewhat higher than the average temperature of planets. And since the temperature of planets may be most varied, so also may be the temperature of animal life. Some are very hot, others are cold as ice — from the point of view of man. I do not talk about those cases when the temperature of environment is somewhat higher than temperature of animal life. In this case the warm-blooded ones are threatened by death, since the brain (heated) ceases its activity. But then the skin or lungs evaporate water, heat is absorbed from the body and the brain preserves normal temperature. For life there is still necessary also certain constancy of temperature. Sharp oscillations of it are disastrous for any organism. Thus, on a few planets which always turn one side to the Sun, the temperature varies from 250° of cold up to 150° and more of heat.

How can one live here? No matter how great the difference of temperature is on the external part of the planet, this still does not exclude life, since the

interior of the planet preserves a constant temperature. Animals digging burrows will find in them relief from excessive heat, as well as also from severe cold. However, the lowest creatures here are helpless. The beginning of development of life, with these sharp temperature contrasts, is difficult. Everything, of course, has its limits, even the survival of life. In places, inconvenient for life of lowest creatures, there can survive the intelligent kind with highest development of knowledge and technology.

Is Sun necessary for the existence of animals? Energy of solar beams is very wide-spread in the Universe: in one Ether Island [galaxy] there can be counted up to a million billion young and old suns, emitting tirelessly their beams. It is clear that majority of animals exist by solar energy. But still this existence can be accomplished by force of another energy. Thus, suns temporarily dies, remote planets almost do not have solar beams, but this still will not extinguish immediately their life. High temperature and chemical energy for a long time still are kept inside the cold surface of celestial bodies. And this gives possibility still for a long time to preserve and to continue life of organisms. Only there is no special need to be fed by these pitiful remainders of celestial energy, since there is an abundance of it in the form of blazing suns. Theoretically, any energy can support life; for instance, energy of motion and rotation of planet, gravity force, heat, atomic energy, and its other forms. How - we will not enter into this now.

An important value has the brain of an animal. Can it be increased at the same growth and how much? Certainly the structure of the brain has great significance, but also the volume of the brain is a good quality, increasing the memory and mental forces. Since we can carry heavy loads, then why can't we carry a more massive head? Mechanics shows that the volume of the brain can, without any damage, be increased by two or three times. Up to now in this, however, we encounter obstacle. On the one hand, the difficulty of births is increased, and on the other - development of brain (in first stage) leads to narrow morality; man renounces himself in favor of close ones and does not provide for posterity. In the second stage, the same development

leads to depression, which kills bright hope, frightens one and leads to nervous disorders, illness, and early death. Only in the third stage — during highest development of knowledge and mind — is there obtained certain equilibrium between egoism and altruism, when man starts to realize the necessity of caring for both himself and for posterity.

The first cause may be eliminated by premature births and subsequent development of embryo in special artificial environment. Man should return as if to the period of egg-laying (birds, reptiles, etc.). Second and third cause are removed by precaution during development of first and second stages and immediate development of the third stage, bearing optimism due to highest knowledge, penetration into depth of nature and high wisdom.

However, the magnitude of brain can also increase together with proportional growth of the whole animal. On Earth gravity prevents the increase of growth. Mechanics strictly proves that mass of brain of animals similar in form, is proportionate to the cube of the decrease of the gravity to which animals are subjected. Thus, on Mars and Mercury, where gravity is twice less than on Earth, the size of brain could be 8 times larger than ours, — certainly, for the same external form of animals. Growth of these creatures would be twice larger than on Earth. On the Moon the growth would be 16 times more, and the mass of brain 216 times more.

This conclusion of mechanics does not pertain to aquatic creatures, since their weight is eliminated by counteraction of water. In water there could appear animals with a large brain. But in water one can't have industry (it is impossible to make a fire), there is little oxygen or solar energy (light) and, therefore, there life did not and cannot go far.

When man will settle in artificial dwellings, in ether, i.e., will depart from Earth and thus conquer its weight, then there, in ether between planets there will not be obstacles for the development of the size of the brain; if one ignores the complexity of a large brain and the organs feeding it, which, of course, will place

limits also on development of cerebral mass.

While man is on Earth (part of humanity will certainly remain on Earth), until then the size of brain can be increased only 2-3 times. It will be ugly, but it is possible to get accustomed to anything. Beauty is conditional and subjective thing.

The lungs of mammals have extremely unsatisfactory structure. This organ should be changed. We will take as an example the digestive tract. In the lowest creatures it has an entrance, but does not have a special outlet. Digested remainders of food leave from the same aperture through which they entered. Thus, locust excretes feces by mouth. This delays the process of digestion. Therefore, highest animals acquired an outlet. They had an advantage over the ones who did not have one. Early blood circulation also was uneven (to and fro). Only the highest form of life had a good valve (heart) and circular motion of blood.

And also the lungs of the majority of mammals, absorbing air and extracting oxygen from it, throw off products of breathing through the same aperture. Thanks to this oxidation of blood is accomplished slowly, organ of breathing has great size and gives little oxygen to animal. Respiratory chamber, just as the digestive one, should have an outlet. Air should enter continuously into one aperture and emerge into the other. That this is possible we can see from examination of structures of insects and birds, who again must expand a great deal of energy during flight. Insects have through-pipes (trachea), through which air flows. They only lack an air valve. However, it is impossible to vouch that all insects lack it. Pectoral muscles in birds are pierced by similar tubes, although mechanism of air motion in them is vague: either the streams of air flow in one direction, or else they oscillate to and fro as in lungs. It is clear only that the air flow in these tubes is evoked by contraction of pectoral muscles during flight (just when there is needed great energy).

It is obvious that evolution of highest animals even on Earth could take another path and come up with animals with a permeable respiratory organ. Such creatures

are completely feasable on the million billion other planets. They perhaps, will also appear on Earth, naturally or artificially when man will undertake the transformation of his body. Physiologists know how great a number of deficiencies have bodies of even highest of animals. All of them should be removed by means of exercise, selection, crossing, surgery, and other methods. We talk only about a few imperfections — for example. Even in people there is not a single perfect, or unimpeachable, organ. Let us note that in many aquatic creatures oxygen, dissolved in water, together with it moves into one direction. For instance, in fish — from the mouth to branchial cleft. Perhaps, due to this fish manage on such an insignificant quantity of oxygen as we see in water.

Is it necessary for man to have gravity and just such as on Earth? With similarity, or external similarity of organisms (with various dimensions, or growth), gravity suppresses growth the more, the stronger it is. This means it decreases also the size of the brain, and consequently also the mental forces. It appears that it is harmful. That complete removal of gravity does not at all hinder life can be seen from the fact that, for instance, aquatic animals, living where gravity (or ponderability) is destroyed by reverse pressure of the liquid, do not suffer at all. Conversely, nowhere do dimensions of organisms attain as great a magnitude as in oceans. A whale on land is helpless, but in water it is frisky as a kitten. An animal, with legs upwards, does not die and does not suffer, although gravity is changed to the opposite. All the more so, it does not suffer in a lying position, when pressure of column of blood decreases a few times. Man also in this position can accomplish swallowing, digestion, and other motions. Baths, destroying gravity in the sick, in many cases relieve them, having besides a medicinal (therapeutic) action. Weakened gravity should decrease the mass of organs of movement (legs, wings, and others), if it does not increase growth of organism. On planets with smaller gravity there should be observed the following phenomena:

1) The smaller the radius of the planet or its gravity, the bigger the growth of the organism.

2) If such is not the case, then organs of motion (leg and others) become very weak or thin.

3) If such is not the case, then jumps of animals or speed of their motion are increased.

4) Perhaps the combination of all three cases, i.e., moderate increase of growth, moderate weakening of leg or pectoral muscles, moderate increase of jumps and other motions. There can be the most varied combinations of the three extreme cases.

On large planets with much gravity there will be the reverse.

One will say, how is it possible to manage without gravity — oceans will evaporate, atmosphere will scatter and the planet will left without that which is vital to life.

We will analyze this in turn. Is it possible to manage without water and air and to what degree are they necessary? Man easily adapts to altitudes where air and oxygen are twice less. There are such mountainous villages. Children, born there, endure excellently the deficiency of oxygen (but travellers are burdened). Healthy people at certain times can endure a four-times-decreased quantity of oxygen. If lungs were permeable, then they would be satisfied with a still smaller amount of invigorating gas. Instead of air, fish breathe, as it were, water impregnated with air... This water streams in one direction (from mouth to branchial cleft), like blood and food of highest animals. Water contains 60 times less oxygen than the atmosphere: however, this does not prevent the existence of fish. Moreover, water creatures live excellently also when oxygen is still much less. One will say, that life is for the fish! But pure oxygen (without water and atmospheric nitrogen), with permeable lungs, will be dissolved in blood very rapidly and will be received no less than is obtained in our land animals.

But how can one manage without atmospheric pressure? Absence of air pressure or other medium leads to bleeding from the nose, throat, and other organs. This is

understood; the strength of blood tubes (vessels) is partly supported by external pressure of atmosphere. Either there is none of it or it is weakened, and here the weaker vessels of nose and throat burst from pressure of blood. Man and highest animals are not adjusted to weak ambient pressure. If, however, people are born in such, live and grow in it, then due to noticed (Lamarc) ability of organisms to adjust to new conditions, their blood vessels become more durable and animals, without harm, will exist in rarefied medium.

Bones of organs of motion are also connected with atmospheric pressure. Without air — there would not be this connection either. But bones will also not disintegrate without air pressure, because they are connected also by tendons and constant stress of surrounding muscles. That this is so can be seen from experiment with gymnastic exercises: man hangs on his hands and legs being subjected to gravity, incomparably greater than the force of pressure of atmosphere on insignificant areas of hinged joinings of bones. The latter nevertheless do not disintegrate. From this it is seen that just stress of muscles alone is sufficient to retain the bone in the joints.

In rarefied medium the evaporation of water should be increased in sweat glands and lungs. But certain animals (dog) do not evaporate water through skin. Hence, there is possible an organism which does not lose water through sweating. There are also such plants (certain cacti). What happens? There are possible creatures, which do not suffer at all from destruction of external pressure. It is true, with such lungs the animals will be unable to regulate their body temperature and will perish. But, if constant [temperature] is maintained then this will no longer be a danger.

There are still many indications of influence of pressure of medium. Thus, lungs of mammals are expanded exclusively by force of atmospheric pressure. We believe, nevertheless, in the possibility of adjustment also of lungs to the absence of pressure. Actually if lungs are permeable and air continuously moves through

them, then they can lose their elasticity as unnecessary, or grow on to the pectoral cage. We cannot analyze everything here.

We now see that animal can manage without gravity and with small amount of gases and gas pressure.

And is gaseous oxygen or other gaseous food really necessary? Absolutely not. Animals can take oxygen internally like food, in the form of its unstable compounds in liquid or solid form. There are a great number of such known in chemistry and more will be discovered in the chemistry of the future. It is possible that there would be required a special organ, like a special stomach, from which oxygen will gradually enter into the blood. Thus, there will be one organism with two stomachs and without lungs. It does not lose water and does not suffer without atmosphere. Such organisms are possible on the Moon and other planets which have no atmospheres or very rarefied ones.

Composition of atmospheres may be extremely varied for creatures with lungs. It is not oxygen alone that gives energy: sodium burns in carbon dioxide and chlorine. Chemistry can give a great number of such examples. Finally, we also have on Earth creatures which live in carbon dioxide, and do not need oxygen (anaerobic). On the million billion planets of one of our Ether Island there is so much variety, so much creative work that it is possible that in no way could the most brilliant human mind comprehend it.

Is food necessary at all? Can't there be creatures, which do not take food, i.e., which absorb gases, water, plants, meat, and salts? It is true that plants can be fed by some mineral substances. But still these substances can be taken as the food of organisms. Atmosphere also participates in this feeding, providing either carbon dioxide, oxygen, or nitrogen (usually through bacteria).

There are also animals similar to plants. They also can be fed by inorganic substances. These are animal-plants (zoophytes). They contain in their body green grains (chlorophyll), by whose action, with the participation of sunlight, carbon

dioxide of air is decomposed to carbon and oxygen. The oxygen passes out into air, but the carbon, with other inorganic substances, will form sugar, starch, and cellulose (carbohydrates), and nitrous and other organic tissue, composing the body of a creature.

Hence, we see only that like plants, animals also can exist with the help of only inorganic foods in the solar energy. Nevertheless, here participate atmosphere, water, and terrestrial soil. Can life be possible without constant participation of these elements of the Earth, i.e., without participation of the environment?

We will imagine an absolutely isolated, special animal. Into him do not penetrate gases nor liquid or other substances. From him they also are not excreted. The animal is only pierced by beams of light. Encountering here chlorophyll, carbon dioxide and other products of disintegration of tissue of the animal, dissolved in the blood, they decompose them, combine and as a result give oxygen, starch, sugar, various nitrous, and other food materials.

Thus, our animal obtains all it needs for life. Food (there is implied that which is formed in the body by action of solar beams) and oxygen are implemented in tissue of animal. But the latter are again decomposed into carbon dioxide and other products of disintegration (urea, ammonia, etc.). Let us assume that all these waste materials are not discarded but enter the blood and remain in the organism. Solar beams again act on them, as in plants to gaseous and liquid fertilizer, i.e., convert them into oxygen and nutrients, which repair the losses of continuously working parts of the body — brain, muscles, etc. This cycle is eternal, until the actual animal itself is destroyed.

That such a creature is possible, we see from the following. We will imagine a quartz (or glass) transparent sphere, pierced by beams of Sun. In it there is a little soil, water, gases, plants, and animals. In a word, this is similar to a huge globe, only in a tiny form. Like in it, there is also on any planet a definite isolated quantity of matter. As in one so in the other there is accomplished the

same known cycle of substance. Our glass sphere presents a likeness of a hypothetical creature, getting along on a constant amount of matter and living eternally. Even if the animals in the sphere die, in their place are born new one which are fed by plants. In general, the glass sphere is immortal, as the Earth is immortal.

But the question is how can there appear an animal whose mass remains constant? It lives, thinks, moves, we will even assume that it does not die. But how does it get born and how does it bear? It is possible to imagine that in the first stage of its life it is developed just like the terrestrial animals; it is begotten from an ovule, the latter is developed in suitable nutrient medium (perhaps with participation of solar energy), it grows, breathes, attains maximum growth, impregnates or produces an egg; then it gradually is converted (as a caterpillar into a chrysalis and butterfly), loses its sweat glands, lungs, and organs of digestion, and is covered by an impenetrable skin. In one word, it is insulated from its environment and becomes that unusual creature which we described. It lives by solar beam only, it is not changed in mass, but continues to think and to live as a mortal or immortal creature.

Cradle of such creatures, of course, is a planet similar to Earth, i.e., with atmosphere and oceans of some sort of gases and liquids. But creature of such form can live also in vacuum, in ether, even without gravity, as long as it has radiant energy. Fortunately, there is no lack of the latter. A million billion childless and "family" suns, young and old, will tirelessly emit it for many trillions of years. When they die or weaken they are replaced by new suns. This abundant radiant energy must be used by such creatures. They surround all suns, even those without planets, and use this energy in order to live and to think. The energy of stars should exist for something!

We talked about creatures, similar to terrestrial planets and animals. We did not leave the limits of known science, but nevertheless our imagination showed us that which the Earth still does not have, but what is possible from the point of view of our narrow (so-called scientific) understanding of substance.

We suspect 80-90 elements, their conversions, protons, electrons, and other work of hypothesis. We arrived at conclusions that organisms could adjust to great number of conditions of life on billions of planets and also outside them. Their forms and functions, it is understood, are much more varied than on Earth – in our planets and animals. The degree of perfection is also more varied. But the latter, in general, is much higher than the highest on Earth. Human genius, in comparison with it, is nothing. And this came from various conditions and abundant times in which there could not be deficiency.

Each planet, with flow of time, is united, removes all imperfection attains highest might and excellent social mechanism; supreme council selects one who will govern his planet. This creature is the most perfect on the whole planet. His qualities gradually spread to the whole population of the planet, but still they cannot be compared.

But the population of the planet is multiplied and its surplus finds a place only in the surrounding solar space. This population is a billion times more abundant than the planetary. It is also governed by elected chosen council and its president. The latter is more perfect than the chairman of highest council of one planet.

Also united are the nearest groups of suns, milky ways, ether islands, etc. Representatives of these public units ascend higher and higher in the degree of their perfection. Thus, besides the ordinary, comparatively perfect population of the Universe, we find representatives of planets, solar systems, star clusters, milky ways, ether islands, etc. Their high qualities are difficult to imagine. They are similar to gods of various degrees.

It seems, why should there be a unification of solar systems or groups of suns? Let, for instance, each solar system live, as best as it knows. What business does it have as to what goes on in the other solar systems? But after all each sun with its planets is not eternal. They explode, extinguish, are subject to various

catastrophes. Before their approach it is necessary to seek a suitable population and unoccupied place of residence for the population. We have to know all about other solar systems. Chairman of their group will coordinate general interests, give needed information, direct where necessary and render assistance.

Can there be relations between neighboring suns? If we now already can obtain certain information about them, then what may be further, when while inhabiting in ether, atmosphere will not prevent the almost infinite increase of telescopes, when we will be liberated from destructive gravity, etc?

Light, indeed, spreads for stellar distances insufficiently fast. Years are needed for it to overcome them. But perhaps, in ether we will find also another medium, lighter one and elastic than ether (like in atmosphere we still find ether). Its invisible oscillations can reach neighboring suns not in years, but in days, even in hours. Thus, conversations will be much more convenient than now.

All this is terrestrial, accessible to simple scientific human mind. But perhaps there is still a higher point of view, now less accessible. Nevertheless, its authenticity is justified not only by persuasive reason, but also by facts. However, it is necessary to stand higher than molded workers of hypotheses — all these electrons, protons, hydrogens, and others.

Actually, what would be the course movement of scientific development, i.e., development of knowledge? At first there were found an infinite number of bodies with different proporties and they were taken for basic and infinite variety of matter. Then all this diversity was reduced to 90 elements. Finally, one arrived at the fact that all these 90 simple bodies are composed only of electrons and protons; ether was tossed overboard. But, after all, the majority of physicists still recognize ether both as a working hypothesis, and unexceptionally rarefied and elastic substance, a particle of which, by mass, is a trillion times less than protons, and a billion times less than electrons*. What kind of jumps are these

*See my Kinetic theory on light.

between mass particles! If the mass of the proton is taken as unity, then mass of electron will be expressed as 1 : 2000, and ether as 1 : ($16 \cdot 10^{12}$). (Ratio of these numbers will be: 16 trillion, 8 billion, and unity).

This confusion is resolved if we deviate from the narrow point of view of contemporary working hypotheses.

Actual matter is the result of evolution of simpler matter, whose elements we do not know. I want to say that once there was matter lighter and more elastic, consisting of particles smaller than electrons. Perhaps, there were particles of ether.

When was this? Well, after all time is infinite, as are space and matter. There is as much as you want of it. No number can express it. All known and imaginary times are absolute zero in comparison with it. Take enough of it — thus we will come to simpler matter.

This "simple" matter is also the result of still "simpler" matter. There was a time when the latter was predominant in the Universe. Thus we can continue without end and arrive at conclusion concerning infinite divisibility of matter due to infinity of passing time.

As you will, but to consider proton or hydrogen as the base of the Universe, to consider it as an actual element, as indivisible, is as strange as if one were to consider the Sun and planets to be elements.

Maybe, someone, some giant, for whom the whole sky is a small particle of matter, and separate suns are invisible, just like for us atoms, - examining in his "microscope" this "sky," finally, will note the sun and will exclaim joyfully: at long last I discovered particles in this "matter," i.e., the sun. But how he will be mistaken if he considers the sun for indivisible atoms.

Thus we also are mistaken in considering an electron, proton, or even a particle of ether for an atom. Reason and the history of sciences tells us that our atom is as complicated as a planet or sun.

But what is this all about? What will the practical conclusion be? I want to say that the infinite quality of passing times open to us a number of worlds, composed of substances, all the more rarefied, all the more elastic. (It is noticed that with decrease of mass of particles their forward velocity, and at the same time their elasticity increased. Therefore, with the complexity of matter elasticity decreases, and with docomposition it is increased). I want to say that evolution also of our matter will continue. In the future it will lead to worlds consisting of particles, more and more complicated, more and more massive. The future generation of intelligent creatures at first will also take them for indivisible atoms. But they also will be mistaken, as we have been mistaken.

Well, what of this? What is ahead, the reader will say. And this, the fact that these epochs vanished into eternity, also created beings which attained perfection, as creatures from our matter attain it. Each rarefied world gave "its" solid, liquid and gaseous substances, which served for creation of rational creatures (from very thin matter). There were similar epochs without end in the past and they will occur without end in the future. One of them is our epoch, with our intelligent creatures, similar to terrestrial ones.

What happens? With our imagination we see an infinite number of epochs in the past and future, and creatures corresponding to them. What are they like, do they have communication among themselves, do they manifest themselves somehow and can they manifest, do they not disappear with the appearance of a new epoch?

Let us give an example. The animals and plants of Earth evolved from a single source — the simplest protoplasm; one can even say from inorganic matter. It was the origin protoplasm from which there was obtained a number of the most varied creatures. Some of them perished, but in general the development of the highest creatures did not hinder the existence, without great progress of the lowest, more ancient, primitive ones.

We see on terrestrial feast of life at the same time, bacteria, infusorias,

worms, insects, fish, amphibians, reptilse, birds, mammals, and man. Only the might of the latter threatens the destructio of hostile creatures. But certain of them can be necessary to him (bacterium and plants), others — are conscious and are useful and there is no need for him to destroy them. They remain.

Wasn't it the epochs, fragments of terrifying times, that saved not only solid creatures of our epoch, but also the lightest creatures of past epochs. Many of them could have disappeared, but not all: useful and perfect ones could remain, as creatures useful to people will remain.

We earlier preached the recurrence of phenomena or periodicity of worlds, their multiple destruction and appearance. This it is, but periods are not quite similar, and they, as it were, in some places descend downwards, because they produce more complicated matter. This is possible to liken to a wavy road: at times we ascend it, then we descend it, while we do not notice that this road, in general, is sloped, i.e., with expiration of each period we stand lower than previously. There is no end, of course, neither for periods (waves) nor for descent (descent or complication and condensation of matter).

action of hands and legs will increase comparatively, because their relative surface will be increased twice.

From the above it is clear that struggle with gravity for a dwarf is significantly easier, that it is more energetic, lively, even absolutely faster. What then kept hindered creatures of smaller growth from pushing aside people of normal growth in the struggle for existence? First of all, dwarfs lose out because of decrease of absolute strength of muscles: in struggle with gravitation they gain, but in struggle with creatures of large dimensions — they lose. Furthermore, the decrease of size of brain would be accomplished by weakening of mental abilities.

Man, Increased to Twice His Size

Instead of 1.8 m. the height of man will be 3.6 m. (5 arshin). Volume, mass, and weight will be increased by eight times. Instead of 64 kilos, our giant will weigh 512 kilos. (30 poods). Absolute strength of muscles and motor members will increase four times. In comparison with the weight of the body it will be halved. If before the man could carry on his shoulders only one, equal to himself, then the giant could carry nothing; all his muscular strength will be absorbed by the mass of his body increased eight times. For work, for transference of cargo, for construction of dwellings his strength will no longer suffice. The giant will hardly be able to drag himself: the least pressure will knock him off his feet.

It is true that the brain of the giant will obtain significant strength. But to what avail is this during physical weakness, in the absence of efficiency and deprivation of all strength by weight of one's body? The state of a giant can be compared with the state of an ordinary yet strong and healthy man, overloaded with weight to exhaustion, without hope of being freed from it.

Work of giants necessary for struggle with gravity increases to the fourth power of their growth; because dimensions corresponding to loads are increased by eight times, and height of their lifting is doubled, altogether the work increases

The relative volume of absorbed food, oxygen, and excretions should double. If the former, normal creature absorbed in twenty-four hours two kilograms of foodstuffs, then the dwarf will absorb half a kilo, which is relation to mass of body will be twice as much; therefore, our dwarf will be more gluttonous than we. For his dinner there is needed a sausage comparatively twice longer, bread of twice the size.

His mechanical work will be comparatively twice greater: he can ascend a mountain or climb stairs twice faster; he can run twice faster (if one were to take into consideration only friction and disregard resistance of air medium). In relation to the dimensions of the decreased body, the effect will be even four times greater. Thus, a normal man ascends his own height per minute, but the short one — four times his body length.

Absolute strength of muscles will decrease by 4 times, so that struggle with a giant or, in general, with people of large growth will appear impossible; the dwarf will be conquered. But the relative strength of muscles is doubled; if he earlier lifted one man with his hands, then now with greater lightness he lifts two like himself.

Comparative resistance of bones and cartilages to breaking will be increased twice, as also resistance of tendons and skin to rupture. If normal man freely carries himself and one more similar man on his shoulders, then a dwarf, counting himself, will carry six, and without counting him — five. It will appear that a dwarf can drag a log approximately twice longer or can drag a heavier log. He can drag, along the ground stones twice bulkier, pull a cart with twice the load and weight. The absolute safe height of falling is twice greater, but comparision with dimension of body it will be four times more. If a normal man can fall without harm to himself for his own height, the dwarf can safely fall from heights four times his size.

The work of any muscle, during one contraction, decreases by eight times, since

its stress will be four times less and magnitude of contraction twice shorter. Due to this the jump remains the same absolute size, but its relative magnitude will increase. Actually, a man of ordinary growth, preparing to jump, straightens out by 30 cm and jumps up, we will say, the same distance, and thus raises his body only 60 cm. The muscles of the dwarf should lift him the same height; however, the straightening of his legs constitutes only 15 cm. There remains a raise above the ground of 45 cm; this means that in relation to growth the jump will be three times higher. If a normal man can jump on a chair, then a dwarf can jump easily on a table. If during work the number of muscular contractions remained per minute the same, then the absolute work would decrease by eight times, and relative work would remain unchanged. But we know that the latter in a dwarf is twice greater. Consequently, the number of muscular contractions per unit time should be doubled. In other words, frequency of motions, number of sweeps of hands, feet, head, etc., should increase twice. This corresponds exactly to acceleration of nervous responses. The dwarf will not only appear as a athlete, inimitable jumper and acrobat, but will be also very lively, fast, and nimble.

Absolute height of stones thrown by hand of proportionate dimensions remains the same, but with respect to growth it will be twice greater. If a man of ordinary height will throw a stone the size of a fist to 10 times his own height, then the dwarf can throw a stone the size of his fist to a height 20 times greater than his. If the first will throw something over his dwelling, then the dwarf will throw the same thing over a house twice the size with respect to him.

The blow of a hand or leg will be proportionate to its mass, i.e., eight times weaker, since the speed of an armed or unarmed hand will remain the same. Thus, the relative force of the fist, hammer, saber, knife will remain constant, but frequency of blows will increase twice.

Swimming will be easy, since the energy of a dwarf is twice greater, and absolute velocity of fall in water will decrease almost to one and a half times; useful

action of hands and legs will increase comparatively, because their relative surface will be increased twice.

From the above it is clear that struggle with gravity for a dwarf is significantly easier, that it is more energetic, lively, even absolutely faster. What then kept hindered creatures of smaller growth from pushing aside people of normal growth in the struggle for existence? First of all, dwarfs lose out because of decrease of absolute strength of muscles: in struggle with gravitation they gain, but in struggle with creatures of large dimensions — they lose. Furthermore, the decrease of size of brain would be accomplished by weakening of mental abilities.

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Work of giants necessary for struggle with gravity increases to the fourth power of their growth; because dimensions corresponding to loads are increased by eight times, and height of their lifting is doubled, altogether the work increases

by 16 times. Meanwhile, absolute power increases only by four times. Consequently, energy with respect to struggle with gravitation is decreased four times. With further increase of growth he is deprived also of the ability to walk, even to lift or to move organs of movement and mechanical work. The longest retained is the ability to move the fingers, tongue, and other small organs; but this also disappears when the giant will attain sufficient growth, because he will no longer be able to surmount their weight. Still large increase of growth will be accompanied by rupture of blood vessels, destruction of all organs, and death.

Man, Reduced by 100 Times

Possibility of observing similarities in internal organs here is hardly realizable, but we will undertake it. Now we are dealing already with a real Liliputian. His height is 10 mm, body surface 10,000 times less, and volume, mass, and weight are a million times less than for a normal. Precisely, his weight will be equal to 0.063 g. i.e., he weighs somewhat more than an ordinary drop of water. Relative force of his muscles will be increased by 100 times. He will lift loads 100 times more in comparison with mass of his body. Relative strength of his bones, cartilages, skin, and other supporting parts will be increased by one hundred times. It is possible to pile on him 200 creatures equal to him, and not one bone in him will crack nor will one muscle tremble; he will haul them with the same ease, as a normal man carries one person.

The struggle with weight is facilitated by 10,000 times. Liliputian will dig out 10,000 dugouts, corresponding to his size, while a normal man is digging but one. Channel, dug by him in the same time as would the normal man, will be in comparison with size of his body 10,000 times longer.

Relative work of muscular contractions will remain the same, but apparent size of jump with respect to body dimensions will be increased by 100 times raising him above the ground — by 200 times. Liliputian without running will jump over a

twenty-floor "skyscraper" and puddles, which appear to him to be lakes. Distance and height of throwing stones will remain the same, but the relative magnitudes will be increased by one hundred times. For swimming one does not exert any effort, since relative force of muscles and surface of palms increases by 100 times.

Air will appear to the Liliputian, in comparison with mass of his body, one hundred times thicker. Wind will also appear 100 times stronger. But the Liliputian is not helpless even against the strongest wind, since his tenacity and the force of his muscles are increased one hundred times.

Our Liliputian can fall from any height. Resistance of air will not allow him to be smashed, since the comparatively large surface of his body does not let him gain a speed of more than 3-4 m per second. Furthermore, resistance to destruction of his bones and other organs is increased by one hundred times. Also at much greater heights he can fall even from clouds.

Little wings, taken into his hands by our Liliputian, give him full capability of flight. He can fly even with a comparatively large load.

Again there appear questions: why was man not turned into a Liliputian in process of evolution, if so, are great the benefits of small size?

First, absolute strength of organs in large creatures is nevertheless greater, and in their struggle with the small ones the latter come out badly. Secondly, mental abilities for large creatures nevertheless are predominate. This adds to the chance of victory in the struggle.

Should there be another gravity on our planet, then the size of the most accomplished people, (and, of all other creatures) would also be changed. For instance, with decrease of weight by 6 times (as on the Moon), the growth of man could be increased by 6 times, his mass by 216 times, strength of muscles by 36 times. The brain would also be increased correspondingly. Such a man, due to the strength of his muscles (and extensive mind), would turn out to be a conqueror, in spite of the fact that in the struggle with dead nature the little people would

have greater physical advantages. This giant, 10 m tall, would turn out to be (during observance of internal and external similarity) a clumsy creature, although moving and jumping as freely as a man on Earth, only six times slower with respect to his dimension. But absolute strength of muscles and mental force would conquer for him all living things of smaller dimensions.

If, on the other hand, gravity increased by 2 1/2 times, as on Jupiter, then the human breed should decrease 2 1/2 times. Otherwise, the weight of people on Jupiter would deny them efficiency and even the possibility of movement by their own muscular strength. Man would be in height 72 cm (1 arshin), would have a brain 16 times less in volume and weight and would be, probably, a very limited creature in mental respects. All other animals also should decrease, and therefore perhaps man, as before, would remain master of small living nature. But his highest progress (connected with machines, inventions, science) would be, probably, very small. It was impossible to expect a development of technology such as that now observed on Earth and which, as we trust, will increase in time to an inconceivable magnitude. On Mars, Mercury, and other small planets and satellites it is possible to expect large growth of land animals and the strongest development of the brain, if other unfavorable conditions do not prevent it: high or low temperature, atmosphere unsuitable for life, lack of water, and other elements useful for development of life, etc.

ETHER ISLAND

By Ether Island we imply the whole known Universe. We want to establish its dimensions, form and construction.

In essence, the whole of it consists of brilliant suns, surrounded by spheres with extinguished surfaces similar to our Earth. They are called planets. The same can be said about Space. It is composed of an infinite number of large and small bodies of the most varied dimensions. Some of them are large bodies – these are suns in the period of their brightness. Others, of smaller dimensions and mass are suns in the period of their extinction. They are dark. Small bodies, not shining for long, they cooled quickly and a large part of them [their existence passed] in darkness. These are planets, their satellite moons and an infinite number of small bodies. Finally, we see still huge, gaseous, quite rarefied nebulas. They are even greater than the suns; they shine weakly. These are suns in the period on their onset. In general, we notice: the smaller the mass of body, the more frequently it is repeated in the Universe, i.e., there are more small bodies than huge ones.

Thus, in the given space there are mostly dust specks, fewer stones (shooting stars), still fewer fireballs (celestial stones). Further, given in order of their quantity, are: small asteroids and moons, medium asteroids and satellites, large

asteroids and moons, small planets, medium planets, large planets, suns, and gaseous nebulas.

Sun, joined by gravitation with other suns close to it and small cooled off sphere-planets [in totality], are called solar systems. The Universe is filled with solar, or planet, systems. They are very far from each other, they are as if secluded, isolated by space. A solar system, in general, consists of several suns and a great number of planets, i.e., dark spheres, similar to Earth. All solar systems were at first irregular, very rarefied gaseous mass. Whence from did it come? The whole known Universe is surrounded by a transparent and extremely rarefied material medium, called ether. In all of its parts through condensation there will be formed ordinary matter, consisting of atoms or their parts known to us. Therefore, mass of ether is not fully transparent. It [contains] atoms. Gravitation unites formed parts of substance, or atoms, into heaps, into irregular gas mist. Thus, the first stage of solar system is the ether state, and second stage is an irregular, hardly visible mist. Thickening more and more, it is condensed and takes the round form of a nebula. This is the third stage. Condensation continues, glow is increased, temperature increases. We obtain the 4th growth of the star — a single gigantic red sun — without comrades and planets. The initial nebula had a weak, accidental irregular motion, which in the gigantic sun turned into forward and rotation motion. From where, in general, did the initial, hardly noticeable motion come? First of all, the mutual attraction of parts of gaseous mass had an influence. Secondly, the gravitation of neighboring masses, i.e., similar nebulae and suns [acted on it]. Under the influence of one thing or another there was obtained irregular motion, which as a result formed two simple motions, rotary and forward. Certainly, it too was never fully regular, which served later as a reason for certain anomalies (during birth of planet).

Gigantic star revolves still very slowly and will form a spherical mass. But this rotation by measure of compression of star (from formation of more and more

complicated matter, having smaller elasticity the more complicated it is) accelerated, axis of rotation is shortened, equatorial line is expanded, sphere of star is more and more flattened, turns into a flat cake. The matter ends with a bursting of the sun.

Here there can be two cases. 1) The first occurs when rudimentary rotation was weak, as a consequence of which prior to bursting (or before burst) the star should have been strongly condensed in its central parts, in comparison with external parts. Then from the gigantic sun there was separated a ring, which we see around Saturn. 2) In the second case, the rudimentary rotation of the gaseous mass was much more significant. Then before bursting the star had an almost uniform density (because it wasn't strongly compressed), which hindered fast rotation. In this case from centrifugal force it was extended into one direction and burst, similar to a divisible bacterium. In this case there were obtained two suns, similar in volume and mass.

What occurred in the first case, what happened to the brillant solar ring? Owing to radiation, the mass of the central spherical body decreased, from this the ring departed and the matter ended in the burst of the ring: at first, longitudinally (into several rings), then transversely — there were formed spherical, rarefied, brilliant, comparatively small suns.

This is the birth of the planet-children. These children — several tens or hundreds — from loss of mass by central star and tidal action departed more and more from their "mother," forming a [luminescent] planet system. In essence, there became a group of large and small suns. But here, the smaller of them cool off, are covered by a hard crust and lose all their brightness. If they are still conspicuous, it is only because they are illuminated by the sun. After the small planets, the others cool off in the order of their magnitude. An ordinary planet system, similar to ours is obtained.

But before cooling off, planets gave birth to satellites or moons in absolutely the same way as their father (main sun) brought them into the world. It is

understood now, why all planets, satellites and the sun itself move and revolve in one direction. All these motions are obtained by them from the Sun. It is understood also why planets are now so far from the Sun. They were withdrawing from it all the time, as now, due to Sun's loss of mass and to inductive braking.

With sectioning of planets and their withdrawal from the sun their rotary forces were all the more exhausted. They were exerted on motion and withdrawal of the planet. Later, after more or less abundant procreation, there always set in a moment when from weakened and [aging] sun there could no longer be expected any further "fruitfulness." The ring, apparently, is separated only once. Then it is divided longitudinally and transversely, forming planets.

In second case, the parts of bursting Sun, almost equal due to their loss of mass from radiation and due to tidal braking, also with draw from each other, forming a double star, a double sun.

With each of the latter with further condensation there could occur one or other of the above-described (according to conditions): or planet systems or double suns.

Thus, there occurred in the sky, joined by gravitation, triple and multiple suns. Mostly we see double suns (30%); there are fewer triple suns, still fewer fourfold suns, etc. In practice this extends to a complicated sun consisting of seven shining members. We considered two extreme cases or, more correctly, two typical phenomena. But among them are a great number of secondary, intermediate ones. In essence, we have an almost continuous chain of phenomena. We will sort out only certain links of this chain. We will imagine a number of gaseous nebulae of identical masses and volumes, but with various rudimentary speeds of rotation. Starting with zero speed, we will end with the greatest obtainable one. We will obtain the following stars in life.

1. Single sun, without rotation and without planets. It does not have children, and, therefore, no grandsons. Since there is no rotation, there is no

centrifugal force (the cause of break away of mass). Such a fruitless sun is very rare, a low probability case; but one can't deny its possibility in infinite space.

2. Weak rotation and therefore the strongest central compression. The ring could not separate, because the cooled, small sun did not attain a sufficient speed of rotation to conquer the force of gravity.

3. A single, not very massive ring is separated, which then departs and turns into a planet.

4. There is separated a more massive ring. From it then there are obtained a few rings and planets.

5. More rings and still more massive planets.

6. Great number of rings and planets of significant mass.

7. Double sun, separated, has smaller mass. Further compression of each sun can give all that is described above.

8. Double sun with equal masses.

9. Triple sun.

10. Multiple sun. Each of suns of last four categories can produce the items described above for a single sun.

The total mass of planets obtained is, in general, the more the higher the category, or the greater the rudimentary speed of rotation of the gaseous nebula. But what occurred subsequently with solar systems, i.e., with suns and planets?

And in those and others there was much more complicated matter than elementary, ether or less simple (electrons, for instance). Therefore, in them there predominated process of decomposition. It produced, at first, in bodies a uniform radiation, then nonuniform, then explosions. Intervals between explosions were extended and the actual explosions were all more and more terrible in their force. We will endeavor to explain their origin. While the matter was gaseous and mobile there were no explosions. But here the central pressure, condensation of matter, its cooling began to prevent continuous singling out of electrons, ether or any other

elementary and, therefore, usually elastic matter. Then this became periodic, i.e., elastic matter was accumulated in celestial bodies until its force could conquer the obstacles of friction, density, hardness, and so forth. Then there occurred an explosion. The stronger was the obstacle to cooling and condensing of matter, the greater the time required, to conquer it. Therefore, both the force of explosions, and their period of onset for each star was extended with its age, with its old age.

There is a special class of stars (Cepheid). The bigger they are the brighter (true brightness, but not apparent brightness) and the greater the pressure and condensing in the center. This means, the greater the obstacles for an explosion, the longer its period and the greater its force. It is even proven that the interval between explosions (period) is proportional to absolute brightness. This gave a means to determine absolute brightness, and hence also distance of star from us. Somehow each aged star starts to detonate even stronger and stronger, even less frequently. Thus, at first, by uniform radiation it loses its matter, and then — with greater and mightier explosions. Cepheids at times give explosions, in which in one second there is radiated more energy than that which our Sun emits in many years. Thus, on the one hand, everywhere nebulae mist and suns are formed from ether medium; on the other hand — these are decomposed and are dispersed into ether and serve as part supplement to independent onset of nebulae from ether. The fate of explosions does not pass by also the small bodies — the planets. They, even before suns, should meet this catastrophe. Actually, their central pressure is small; therefore, and obstacles for triumph of elasticity of decomposed matter over gravitation are less. Perhaps also our planets have exploded more than once as, for instance, the Earth. But the mutual gravitational attraction of their parts again gathered them into one mass. A small planet (much smaller than our Moon), between Mars and Jupiter, probably, exploded once; its parts were not joined back and here is the origin of the swarm of angular asteroids. The parts could not be joined again into a planet here for this reason: The planet did not burst at once

into a great number of parts, but roughly in half; the halves had second explosions later, etc. The phenomenon could have been so complicated that under the influence of Jupiter and other planets the asteroids became small independent planets. Due to all of the above, destruction rules in the Universe, just as regeneration does. Its general [picture] remains unchanged.

Ether Island constantly contains in itself:

1) Embryos of matter in all parts of the ether. It will be formed independently of medium or is ejected by celestial bodies.

2) Irregular gaseous nebulae, as result of gravitation.

3) Planetary (i.e., spherical form as a planet) nebulae, ancestors of suns.

4) Gigantic single red suns.

5) Yellow suns of smaller mass and dimension, but greater density and temperature.

6) White suns of still smaller dimension and mass, but still greater density and temperature.

7) Blue suns of still smaller dimension and mass, but of higher density and temperature.

8) White suns, with temperature, mass, dimension still less, but growing density.

9) Yellow suns. Temperature still lower, also the volume and mass, but density still increases. Explosions are frequent and are weak.

10) Red suns – dwarfs. Volume, mass, temperature still drop and only density is increased. Explosions are rarer and stronger.

11) Dim stars. Explosions are still stronger.

12) Dark stars, cooling from surface like planets, and periodically exploding, until they disperse in the ether. However, all suns explode except for the young gigantic ones.

From what moment of this age of the star, from which of its periods there starts the birth of children of suns and planets, is unknown. It, however, depends upon

the elementary speed of the ancestral nebula. Paying attention only to series of suns, on their posterity, we will encounter such planet system (glittering or dark):

1. Suns without planets. They can be of any age, if there is no rotation.
2. Suns with one single planet.
3. With two.
4. With several.
5. With many.
6. Sun with a smaller sun (double) and with many planets for each.
7. Sun with an equal comrade (another sun). Both have planets.
8. Triple sun with planets.
9. Triple sun with planets (not counting little Vulcan).

Most frequently repeated are average conditions, average initial speed of rotation and average number of planets. One cannot affirm that our planetary system falls in the average case, since nearly 30% of all suns are of the double type. It would rather fall in the group of systems which are poor in planets and in magnitude. Actually, the most massive of our planets Jupiter is a thousand times less in mass than its sun ("mother"). And the mass of all planets of our system is 700 times less than that of the central luminary. It is probable, that majority of solar systems after period of procreation are richer in planets than ours: their families are more extensive – especially those of double suns. Nevertheless, we know (with all of its minor details) only our own planetary system at all well.

Diameter of orbit (diameter of annual circle) of our planet Neptune is less than a billion versts*. And this is the dimension of our planet system (not counting Little Vulcan**). Distance of the nearest solar systems is around 40 trillion versts, i.e., is it some 40,000 times greater than dimensions of our system. In

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*Translation Editor's Note: 1 verst = 3500 feet, i.e., .66 mile.

**Translation Editor's Note: Pluto was still undiscovered in Tsiolkousky's time.

general, the distance to neighboring solar systems on an average is near 400 trillion billion [versts], i.e., 400,000 times greater than the diameter of our system. Hence, it is clear that dimensions of solar systems are very small as compared to space dividing them. Between them are terrifying ether deserts.

We know of approximately 10 to 500 billion solar systems, revealed by telescope or photography. They constitute a group which is called the Mi ky Way. The name [sounds somewhat] strange. Its form is like a flat cake or scroll. In its center the stars are nearer to one another, but the further to its edges the further apart the stars. To determine the dimensions of the Milky Way and [other systems] we will turn to another unit of distance, called the light-year. It is somewhat less than ten trillion kilometers, but we will take it as an even 10 trillion. Such is the distance that light travels within one year ([traveling] 300 thousand km sec). Dimension of our planet system in such units will be expressed as 10 hours, i.e., light will pass the whole diameter of Neptune annual way in 10 hours. Thus, here, at a distance of three thousand of such units from the center of the Milky Way, suns become already 10 times further, i.e., they are at a distance two times and more further from each other. At a distance of 15,000 light years stars are almost non-existant. Here they the rarest of all. Diameter of Milky Way is taken as 30 thousand light years. This is the diameter of the flat cake of the Milky Way. Its thickness is 6 times less, i.e., 5 thousand light years. But the Milky Way does not end here... Beyond the stars of the Milky Way in ether vacuum there are still groups of suns, called star clusters, or star collections. They constitute, as it were, the continuation of the flat cake of the Milky Way and, therefore, belong to it. They expand its diameter, but not the thickness. In these groups the stars are located even more frequently than in the center of the Milky Way. In some, they are 3,000 times more frequent, i.e., there the suns are 14 times closer than in the center of our Milk Way.

In the center of the cluster the stars are more frequent than on its boundaries, as also in the Milky Way. Dimension of clusters are similar enough. Their diameter

is about 500 light years. But they are located much further than outskirts of Milky Way. The latter together with its solar accumulations is already up to 300,000 light years in diameter. Stars and star clusters move in various directions. [It seems] As if their path were a straight line. The cause of motion, of course, is the attraction of combination of stars of the Milky Way. Others notice in the motion of suns certain regularity: namely, two-three flows of stars. The speed of stars and their groups is ordinarily from 10 to 100 km/sec. Star clusters on the outskirts of Milky Way, are drawn along by it for a long time and have a speed up to 100 versts per second and more. However, stars also sometimes move unusually fast, go up to 500 versts per second.

I indicated that star clusters are mostly located in one direction or in one plan with the scroll of the Milky Way, constituting with it one group. But there appear still foggy specks, located evenly all over the sky. V. Gershel' thought that these were other Milky Ways, but then began to doubt it. For a long time after that they were considered parts of our Milky Way, gaseous nebulae, embryos of suns. But here, with the perfection of telescopes and photography, in them there were noticed separate stars and explosions of suns. Their extraordinarily weak force gave us the possibility to guess regarding the great distance they are from us. It turned out that these spiral specks are far beyond the borders of our Milky Way and star clusters, at a distance of millions of light years. It is understandable why for a long time we could not distinguish them from gaseous nebulae. Now more and more one is convinced in the fact that these specks, having frequently the form of scrolls and called, therefore, spiral nebulae, are nothing else but distant Milky Ways, similar to ours. Hence, they also contain billion of planet systems. The number of other Milky Ways is determined by millions. Their distance from each other is millions of light years, and the diameter of the whole group of new Milky Ways - hundreds of million light years. In my composition "Kinetic Theory of Light" I proved that ether spreads only over a few hundred million light years. Further it is rarified

immeasurably, as the highest layers of our atmosphere are rarefied. Beyond the boundaries of the ether there starts some other matter, infinitely more rarefied. Therefore, I named a known group of Milky Ways Ether Islands. Beyond it probably, there lie other similar islands, but about them we cannot obtain any information, since light cannot pass through the etherless space between them.

Our Ether Island rushes with all of its ether with a huge, unknown speed to an unknown destination. This speed also cannot be determined, since we cannot see the other Ether Islands.

Speed of spiral nebulae, i.e., other Milky Ways, attains thousands of kilometers per second. But this is relative speed, i.e., with respect to ether or Ether Island which is considered motionless.

Thus, the planetary system is a group of celestial bodies, consisting of one or several suns and a great number of planets similar to our Earth. They are located in one plane, move and revolve in one direction. All systems move rectilinearly with speed from 10 to 100 versts per second and more. Its dimensions are determined as billions of kilometers, or tens of light hours.

Milky Way consists of a billion gaseous nebulae and suns: childless, family (i.e., planet systems) and dying types. Explosions of the latter fill outer space with a great number of comets and help the formation of new gaseous nebulae.

Comets, in all probability, in essence are solar spittles. The majority of them fall back on the suns, but a few, the most successful ones have speed which conquers the gravity of suns, and they constitute comets with long period of rotation or are wondering without a period, rushing between suns, from one luminary to the other.

Suns of all ages are divided into Milky Ways by abysses of spaces, measured in hundreds of trillions of versts or tens of light years. These abysses are hundreds of thousand times greater than dimensions of planetary systems. They move rectilinearly in all directions, and only trillions of years distort their way.

Penetrating the Milky Way, they vacillate in it and can emerge from the sphere of its gravitation.

On the outskirts of Milky Way, as its continuation, we have star clusters. These are, as it were, little Milky Ways. Their size is hundreds of light years. The distance [between them] is measured in thousands of light years. There are not many of them. They move fast and as if fall to their Milky Way.

Ether Island is composed of limited spherical mass of ether and Milky Ways floating in it, among which is also our's. Those, i.e., spiral nebulae, number in the millions. Their dimensions are similar to the dimensions of our Milky Way. The distance of the nearest ones is measured in millions of light years. Thus the abyss dividing them, is tens of times greater than their dimensions. Whole Ether Island includes many million billion suns of all ages and [many] billion billion planets.

But also Ether Island is only a small (even infinitesimal) particle of the Universe. As a drop is small in comparison with the ocean, as an atom is insignificant in comparison to the Earth or the Sun, so also is Ether Island inconspicuous in comparison with unknown Space. But this also is incorrect; it is still infinitely more majestic.

<...>

About the limitedness of our knowledge it is possible to say the same as about the Earth, the Sun, the Milky Way, and Ether Island, that it is immeasurably small.

BEYOND THE EARTH'S ATMOSPHERE

Experiments have begun with reaction-powered automobiles* and the same kind of airplanes. Accounts show that these experiments will not lead to a more perfect automobile or airplane, because use of explosives in automobile or airplane will appear uneconomical at those speeds which they can obtain in air. But these experiments have another extraordinarily important significance. A reaction-powered automobile and airplane, built according to plans shown in my composition ("Space Rocket." Practical Preparation), will train us to operate a rocket airplane and to ascend higher and higher.

At high altitudes it will be necessary to utilize a tightly closed cabin with sources of oxygen and absorbers of human secretions. The heights will gradually be beyond the limits of troposphere and we will attain vacuum, with practice and improvement of airplane. Return descent to Earth will be produced by gliding. These are the kind of rocket shots, jumps into air, which can lead to flights outside the atmosphere.

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*Translation Editor's Note: Tsiolkovskiy uses the Russian word "avtomobil'"; he apparently means by this a satellite-and-carrier combination, as we know them today.

Absence of resistance of air and centrifugal force there, at speed near 7 - 8 km. per second, will give the rocket airplane a stable position outside the atmosphere and outside the Earth. The device becomes an earth satellite, a little moon, and its stability is the same as that of any planetary satellite. Eternal motion, eternal constance.

If it were not deterioration of the rocket air and the same absence of food, nothing would hinder us from completing a peaceful happy life in ethereal solitude.

The rocket should have windows, sunlight, fertile plants which can clean the air of the rocket and give suitable fruits for feeding and restoration of strength.

The pressure of light will give possibility for the missile to depart from the Earth and get into its orbit, to approach the Sun or to depart from it, in general, to travel within the limits of our solar system.

This matter is still far from reached, but we want only to describe here the phenomenon and condition of life of plants and animals in ether, planning an arranged existence of man in special dwelling, a little Earth satellite or Sun.

Let us assume that our rocket is somewhere on the Earth's orbit but far from it. However, it makes no difference where it is; only, the motion of it should be free, like the motion of a celestial body. Then almost all phenomena will remain the same as near the Earth (outside the atmosphere). Only within its proximity it will influence with its warm radiation, and, darkening the missile periodically, produces days and nights.

We will take the simplest conditions: distance of rocket from the Sun is equal to the distance from it of Earth and the latter is remote from the device. Both conditions are observed if the rocket is in terrestrial orbit at diametrically opposite points.

We have an eternal day and virgin beams of the skies. Certainly, there are no clouds, no foggy weather, no winds, no dampness, no storms, no earthquakes, etc. But the closing of the shutters of the windows can always give the darkest night at our will. The rays of the Sun, before falling on man, have to pass through ordinary

glass; otherwise the ultraviolet rays will kill living creature. Plants can be illuminated also through quartz glass. It is possible that for certain of them this will be useful.

Temperature inside the rocket will depend upon its construction and the properties of the surface; absolutely the same, as temperature of any planet. But with the latter we so far cannot manage, in view of its greatness and low number and weakness of people. The temperature of missile can be controlled easily, i.e., it is possible to obtain in it from 270° cold to 150° heat. With the structures of Earth this cannot be done, because air surrounds them, and heats and cools them. Rocket is surrounded by vacuum. In order to obtain the highest temperature in a missile, it is necessary to turn to the Sun part of dwelling, to make it transparent, permeable for greater quantity of solar rays. Furthermore, inside the rocket they should fall on dark surface, absorbing rays of light. The shaded part of the dwelling should be covered by one or several layers of brilliant silver-plated surfaces, which hold thermal and light beams in the rocket and do not let them escape into celestial space and cool the dwelling.

To obtain the lowest temperature it is necessary to turn the rocket in such a manner so that its brilliant surface would be turned to the Sun, and the transparent side remains in the shade. Then the rays of the Sun will be reflected, not heating the rocket, and its heat will freely depart into space through shaded side.

The surface of the rocket can be arranged to be movable; then, without turning it, we can obtain a desired temperature; from 270° cold to 150° heat.

Is it possible to attain anything similar on Earth! How convenient this is for life, for technology, for plants, and animals. One can use various degrees of heating: for disinfection, for technical matters, therapy, baths, for warming of old men, the weak, the newborn, for liquefication, freezing and preservation of gases in small volume, for best growth of plants, and so forth. Not only are wood and artificial illumination unnecessary, but by special methods it is fully possible

to obtain foci with the temperature of the Sun (at its actual surface: 5 - 7 thousand degrees). We will not talk about this here. But such temperature will liberate us from fuel for all technical productions.

The dwelling and bodies inside it and around it are attracted by the same force, for many hundreds of versts of distance; this is the resultant force composed of many constituents, -- the gravitation of Sun, Earth, planets, stars, etc. This resultant changes the speed of the rocket and all its surrounding bodies absolutely equally, like the flow of river carrying a pile of chips. Therefore, if the body of the rocket were at relative rest, then this rest will not be disturbed, no matter how much time and how strongly gravity force would act on the rocket and on group of its bodies.

In brief, the rocket, its parts, and bodies inside and outside of it are as if released from gravity. For the rocket's inhabitant, whether he is inside the rocket or outside of it, there is no gravity. For instance, on the planet all bodies fall. In the rocket there is no such condition. On Earth there is a top and bottom. In a rocket such do not exist. On Earth high slender bodies should [to rise] upwards, [tossed] ones should return back. An object, however, thrown from a rocket does not return to it: it flies completely away (actually remains in the circular orbit of the rocket around the Sun: only at cosmic speed they depart from the Sun and can even leave it).

All bodies of Earth (even gases) are joined with it by the force of gravity; they are fixed by a chain of gravitation. Nothing is joined with rocket, however: that which is thrown away leaves forever. Gas is dispersed. Attraction of the rocket itself is even difficult to note — it is so small. On Earth walls tumble, old buildings are destroyed by weight, even mountains crumble , man falls into a pit and is injured. In space there isn't any of this. Constructions, out of any weak material and no matter how clumsy and huge (in dimensions up to hundreds of versts), will remain intact.

What benefits this presents to the ether constructions. Motionless (in relation, of course, to the rocket), not propped up by anything and not suspended, an object remains forever motionless. A revolving object always revolves. Tragic is the position of man without support; if he does not have forward motion he will not move from his place, in spite of all efforts of willpower. Actually, only the center of gravity of an object remains motionless. A man can twist arbitrarily, also can assume any position; he can move his limbs and, of course, can talk, if there are gases around.

If, however, there is support: a wall of dwelling, stone, timepiece, hat, then one should only repulse or throw any object, and you move evenly and rectilinearly, until some obstacle will stop this motion: wall, object, blow, force, resistance of air, or other medium.

And this constance of motion presents in ether a great advantage. There a joint move, of at least a thousand versts, is nothing, because speed once obtained never leaves without cause or obstacle. Neither horse, automobiles, railroad, steamers, dirigibles, airplanes, nor, alas, even legs are needed. Legs can be useful only as a source of muscular force. Motor action is needed, but only for work, not for moving. For instance, for filing, forging, splitting, pressing, rolling, and so forth.

With apparent absence of gravity man can take any direction. Top will seem to be where the head is, and bottom where the feet are. But this illusion will vanish with time.

Bodies do not press one upon the other. Therefore, there is no need for furniture, tables, beds, pillows, (furniture is replaced by light nets and grids for distribution or to station objects). This together with desirable temperature releases man also from footwear and clothes. What an incomparable relief!

The absence of gravity cannot harm man, and it is directly beneficial for plants. And on Earth, while getting into water, man almost loses gravity, but this

harms only those with high blood pressure, sick and old, increasing the influx of blood to the brain. Lying down also brings pressure of blood (from gravity) almost to zero. Lying down for years also would not kill a man. While lying down on Earth there is, nevertheless, pressure and from it there are formed bedsores. There is none of that in space. Finally, even the position of man with legs upwards, directing the pressure of blood in the opposite direction, can be endured. It is clear that the absence of gravity cannot damage more than bathing or lying in bed. Young organisms, born in ether, adjust rapidly to space without gravity. Lying in bed is a burden because it is accompanied by idleness which does not exist in ether.

No functions of man are disturbed by the absence of this force. One can swallow, drink, eat, defecate on Earth not only in bed and in water, but even with legs upwards. This clearly indicates the possibility of the same acts in ether. Even if it were necessary to have gravity for easing of these acts, then it wouldn't take much to obtain it in ether through rotation of rocket. The centrifugal force occurring from that, does not differ from gravitation. Here the convenience is also in the fact that this artificial gravity can be much or little according to desire; its magnitude increases with speed of rotation. The latter is of no consequence, because rotation in vacuum never stops, i.e., there is no need for continuous power consumption.

What sort of benefit do plants derive from terrestrial gravity! It only wrecks heavy old trunks of trees, bends branches, and breaks them (especially those with an abundance of fruits), hinders vegetable juices to rise to heights. Plants expend uselessly a great deal of substance and solar energy on creation of trunks and branches which could be much thinner and lighter without gravity.

The only inconvenience of life in ether is the support of certain gas pressure around man, without which terrestrial creatures, especially the highest, cannot get along. Gases consist of mobile particles and their retention requires hard, strong shell, closed from all sides. Any rupture of it will let out the gases sealed in

it, and animals die without the gases. But multichamber dwellings can be made in ether, with chambers isolated from one another. When the shell in one of them is spoiled and starts to release gas (which the manometer indicatos), then people take measures for correction or temporarily pass into neighboring section with an unbroken shell, locking the passage tightly behind them.

For work in vacuum and, in general, to go out into the ether of space there are needed special clothes impenetrable for gases, like diver's suits, with a reserve of oxygen and absorbers of human secretions.

However, in ether man will change gradually in hundreds of years, and vacuum, nongaseousness, direct sunlight will not immediately kill him as now. The danger of vacuum should be reduced. For now, i.e., to begin with, man will have to look at the ether abysses surrounding him through windows of his dwelling, or through the glass of a suit (pressure suit).

On the solar side he will see the Sun bluer than it seems through terrestrial atmosphere. In the shade, with his back to the star, he will see a black sky, studded with non-blinking polychromatic stars. Their pattern is the same as that visible from Earth; however, the latter will appear as a star, also the Moon will be like a spark, only less distinct.

Interesting is the position and sensation of man alone, in safety clothes in ether: both above his head and beneath his feet, there is nothing, i.e., there is no support, no soil, no overweight. It will appear to him as though he occupies the center of a little black sphere, covered with an infinite number of stars. It seems that all you have to do is reach out to get one. The illusion is striking. The Universe appears absolutely insignificant. Deception of proximity occurs from extraordinary clarity, clearness of picture of stars and from their infinite distances. On Earth the atmosphere darkens the objects and, therefore, the darker they are, the more blurred they appear. Here there is no atmosphere, there is no blackout and, therefore, the stars seem close by and all at the same distance.

We will add several words about the plan of the work which should be followed to create a celestial ship.

The details of experiments with rocket automobile are unknown. In any case, they will enlighten us quite a bit. I already indicated which path to take.* If we now did not follow it, that's only a practical concession, because the indicated path is not so simple. In time we will take it anyway. Now I will repeat briefly my reports.

Elements of explosion should be maintained separately from each other and be pumped into a combustion tube. This way we attain safety and avoid heavy tanks. The pipe should be conical with an angle up to 30°. This reduces its length by hundreds of times. It should be cooled. A reaction-powered automobile should have three kinds of rudders, effective both in air and also in vacuum, while the detonating occurs. They are: rudders for direction and altitude, and rudder for lateral stability. All of them are placed in the flow of bursting gases, i.e., opposite the outlet or socket, because they will emerge thinner, lighter and more durable. The uniformity of their action demands the same.

At first there is practiced the use of the rudders of direction and altitude. For that the automobile has one transverse axis with two wheels on its ends. It is possible to first practice with the directional wheel, then with both.

Then there is needed an automobile with one wheel and to the preceding exercise one should add still another exercise, with lateral stability steering. These experiments do not require takeoff.

When we will know well how to control three rudders, can add to our automobile a pair of wings like those of aircraft. But flights should not and cannot continue further than exhaustion of explosive material, because without explosion our automobile rudders either do not act, or their work is insufficient (since these rudders have a very small surface).

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*See "Space Rocket." Experimental Preparation.

In order to take off and manage the aircraft also after detonating, there is needed still another system of rudders with a large surface, similar to that of an airplane. With the two systems we can reach an altitude and speed prior to exhaustion explosives, and then descend by gliding, which is impossible without an airplane system of controls.

Both systems of rudders (although they could be combined into one) are necessary also for flight outside the atmosphere, because no matter where we fly, even into vacuum, from there it will be necessary to descend on earth by gliding since all explosives will have been used up. One cannot count on their constant abundance in reserve.

Only by means of numerous and dangerous experiments is it possible to produce a system of an interplanetary ship. All projects existing till now are only diagrams or fantasies. Critics of rocket automobiles and airplanes consider absolutely justly the rocket method unacceptable because it is not economical. Vallier only indicates methods to decrease high costs of this motion. Method of reaction propulsion may be indeed thrifty when the speed of the ejected material is close to the speed of missiles. The same occurs only in celestial ships. For ground and air missiles it is necessary to use methods, shown by me in my composition "Resistance of Air and Fast Train."

SCIENCE FICTION IN THE WORKS OF K. E. TSIOLKOVSKIY

B. N. Vorob'yev

> "...Even the discovery of differential and integral calculi wouldn't have been possible without fantasy. Fantasy is a quality of greatest value...".
>
> V. I. Lenin

The whole world knows the name of the creator of the theory of jet propulsion and of interplanetary communications -- Konstantin Eduardovich Tsiolkovskiy. This great Soviet scientist, introducing a great contribution to science in this works in the area of cosmonautics, aerodynamics, aeronautics, simultaneously was author of many remarkable science-fiction products.

In the process of research work of K. E. Tsiolkovskiy they sometimes were as if first the initial "evaluation" of the development of new ideas. About this sequence of creative process the scientist himself remarkably said: "at first inevitably comes a thought, a fantasy, a fairy tale. After them proceed scientific accounts. And finally the accomplishment marries (follows) the thought."*

In just such a way he proceeded during the development of questions of jet propulsion and interplanetary communication. Being in these absolutely new branches of human activity an authentic scout of science and a trailblazer, K. E. Tsiolkovskiy

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*K. E. Tsiolkovskiy. Exploration Outer Space by Means of Reaction Devices. Kaluga. 1926, p. 3.

also strove in his science-fiction works to prepare the public to the perception which he proposed, as practical preparation to the penetration of man into Space! Besides that, work with science-fiction publications stimulated him, at least in the first approximation, to produce calculations for checking of preliminary conclusions, which then obtained further development. This process was completed by publication of the scientific work in its final form, including the complete, thoroughly conducted mathematical analysis.

Thus, the written science-fiction productions on the subjects which K. E. Tsiolkovskiy led him closely to new problem and forced to start its scientific development. About this he narrates in his article "Only Fantasy?" which he wrote in 1934 - 1935, when he was the chief scientific consultant of the science-fiction film "Cosmic Journey."

"Nothing interests me as greatly, — wrote then Konstantin Eduardovich, — as the problem of overcoming terrestrial gravity and space flights... I am already 78 years old, but I still continue to calculate and to invent concerning jet machines. How much I have thought over, what kind of thoughts crossed my brain! These were already not fantasies, but exact knowledge founded on laws of nature; new discoveries and new compositions are being prepared. But fantasy also attracted me. Many times I undertook the composition on the subject "Cosmic Journeys," but ended because of my attraction to exact compositions and passed on to serious work. Fantastic stories on the subject of interplanetary trips carry new thoughts to the masses. He who works with this is doing a good job; he evokes interest, awakens activity in the brain, stimulates sympathizers and future workers with great intentions."*

Confirmation of this we find in the science-fiction productions of Tsiolkovskiy, which were saved; they contain in embryo those ideas of his discoveries and inventions, which later perpetuated his name. Therefore, of significant interest are

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*K. E. Tsiolkovskiy. Only Fantasy? "Komsomolskaya Pravda," 23 July 1935.

not only completed productions of the given genre, but also separate fragments and sketches. After all, most of them pertain to the same time when he developed theoretical bases of the new science of astronautics, whose transformation made our generation the initiator of a new epoch in life of humanity — the epoch of space flights. After all, the realization of these, strictly based on Tsiolkovskiy's proposal as the world is now convinced, transformed the most ancient of sciences — astronomy — from purely speculative into experimental.

The science fiction, the constant companion, and sometimes predecessor of outstanding scientific works and inventions of Tsiolkovskiy, is extraordinarily characteristic of his creative work and factually is a "curiosity" which V. I. Lenin so valued, and about which he wrote to G. M. Krzhizhanovskiy. "I Love People with Curiosity..." This "curiosity" and Tsiolkovskiy generously shared it with the people became an inalienable part of his work.

Graphic illustration comes from pages from the still-preserved first "notebook" from Tsiolkovskiy's youth, 1878 - 1879. Expecting in Ryazan, an assignment as a teacher, he day-dreamed over this notebook with pencil in hand, made sketches of unparalleled, most fantastic instruments and devices; the first sketches of future monographs, dedicated to "free space." Tsiolkovskiy was then 23 years old. And then this fantastic "curiosity," accompanied by mathematical analysis strictly founded on the basis of laws of physics and celestial mechanics, took the form of the world's first design of a spaceship with reactive thrust and lay the basis of further works of scientist in the given area.

Included in this collection are ten science-fiction works of K. E. Tsiolkovskiy, related to his various periods of the creative power of the scientist — from 1893 to 1929.

Among the great quantity of his published productions, and also the unpublished works, these science-fiction compositions make up a comparatively small volume. But they played an important role in the initial stage of development and preparation

for publication of basic works of the scientist on jet propulsion and interplanetary communications. First monograph on these questions, "Free Space," was written in Borovsk in 1883; in it there was for the first time formulated an idea: on spaceship there will be a jet engine. In the form of exposition the monograph was close to a science-fiction work.*

In his science-fiction works Tsiolkovskiy was skillful in finding strikingly bright "descriptions and words." And at the same time — what is especially valuable in them — the author remained entirely on scientific ground. These compositions are permeated with the deep conviction of the scientist that it was, we can assume, his belief that in the distant future humanity would arrive at these bold ideas of his. And the firm conviction, expressed in captivating form, involuntarily is imparted to the reader and forces him to ponder over the picture of the future mastering of Space as sketched by the author. Such is the history of the creation of science fiction by K. E. Tsiolkovskiy's compostions in its shortest account.

In 1892 in the life of K. E. Tsiolkovskiy, who then was occupying a modest position as a teacher of arithmetic and geometry in primary school in the city of Borovsk, there happened an important event. He was transferred in the same capacity to a larger city — Kaluga. After the transfer Tsiolkovskiy was convinced that he now was in a somewhat better situation than in Borovsk. In Kaluga he soon met with people participating in literary work. They not only were interested in his scientific works, which he continued at the same time with his teaching in school, but also strove to render him their assistance. This was expressed first of all in the fact that the new acquaintances helped to print in Kaluga the second part of his book "Controlled Metallic Aerostat" (1892), which had been circulating in Moscow, and then helped to publish in 1893 in a Moscow journal "Around the World" the first

*In "Free Space" there was given fundamental power scheme of jet ship and a general description of its construction. It was published for the first time in Volume II of collection of compositions of K. E. Tsiolkovskiy. Publishing House of the Academy of Sciences of the USSR, 1954, p. 25 - 68.

science-fiction narrative "On the Moon," subsequently appearing as a separate publication.*

In this tale Tsiolkovskiy, on the basis of scientific sources thoroughly studied by him, in an entertaining manner acquainted the readers with celestial body the nearest to us — our planet's satellite, the Moon. He wrote his composition in an entertaining manner, as the story of a young man attracted to questions on astronomy, about which he dreamt during a prolonged lethargic sleep. In the dream the young man saw himself together with his friend, physicist, transfered to the Moon, on which they travelled, conducted observations, made scientific experiments, and experienced a great number of adventures. Finally, during the long and cold lunar night they began to freeze, but... the young man is awakened and resolves to describe all he has seen in his sleep.

The situation which the first people arriving on Moon will encounter is described excellently and is saturated with valuable informative material. In spite of the fact that the narrative was published for the first time in the past century, time gave evidence of its success and it is still read with captivating interest. It arouses particular interest now when, after the delivery of the State marker and contents by the Soviet rocket to the surface of the Moon and successful photographing of the opposite side of the Moon from aboard the Soviet automatic interplanetary station, the time has approached for man's flight to the planet nearest Earth.

In 1894 Tsiolkovskiy finished a new, great science-fiction writing — "Change of Relative Gravity on Earth."** First half is dedicated to the question of how it would be possible to organize in interstellar space the study of a change of relative gravity. Tsiolkovskiy describes in detail the device of special construction for

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*Manuscript of tr s book was prepared by him in 1887, when K. E. Tsiolkovskiy lived in Borovsk. About this there is an inscription on the copy of this book, saved in the Archives of the Academy of Sciences of the USSR.

**Archives of Academy of Sciences of USSR. F. 555, op. 1.

these purposes in Space, which he names "Stellar House," describes in detail its devices and tells how experiments can be produced in it. However, in this product he still does not talk about how man will be able to penetrate into interstellar space and to move there, in order to construct the "Stellar House." Meanwhile, in "Free Space" written by him 9 years previously, Tsiolkovskiy already considered the question of the method of movement of man in Space and gave fundamental diagrams of the construction of a reaction-powered spaceship. In the second half of the manuscript of "Change of Relative Gravity on Earth," Tsiolkovskiy describes in fantasy form the phenomena which man would observe on certain planets and asteroids. However, the author did not prepare the whole manuscript for press. In it there are, for instance, such, unfortunate places by form, as conversations of cosmic traveller with "inhabitants" of celestial bodies. Tsiolkovskiy finished only certain parts of the manuscript, namely short descriptions of imaginary journeys to the planets Mercury and Mars and the large asteroids Ceres and Pallus. The given work was published for the first time.

In 1895 Tsiolkovskiy completed the new science-fiction book "A Dream about the Earth and the Sky and the Effects of Universal Gravitation," at the same time printed in Moscow by a separate publisher.* In this work he for the first time, although still carefully, sometimes in veiled form, bares his far-reaching scientific aspirations. Depicting in the beginning the majestic picture of Universe and revealing the significance law of world-wide gravitation for life of humanity, the author tells then, as though in the form of illustration, about fantastic events: gravity disappeares from Earth and there begins inconceivable chaos. Further there is developed the idea of the necessity of creation of artificial earth satellites, like the Moon, for scientific purposes. Here for the first time there is applied this term with indication that "the speed necessary for excitation of a centrifugal force [capable of] destroying the attraction of Earth... should reach up to 8 versts per second,"

*K. Tsiolkovskiy. Dreams about Earth and sky and Effects of Universal Gravitation. M., Published by A. N. Goncharov, 1895.

that the altitude of a flight "outside the limits of atmosphere [is] about 300 versts from Earth's surface"* (by this figure was determined then in scientific literature its [the atmosphere's] altitude). Tsiolkovskiy also considers method of movement in Space, by the use of the force of reaction, and also describes "solar machines" which man will be able to apply there as sources of energy.**

Tsiolkovskiy continues even further and more detailed development of his basic ideas about interplanetary communications, accompanying them with further calculations.

In 1895 the question of interplanetary communications already was developed mathematically by K. E. Tsiolkovskiy, but not published. In 1896 he began to write the science-fiction narrative "Beyond the Earth," but, according to him he got only to the 10th chapter. In 1903 in the journal "Scientific Review," finally, there were printed the first chapters of great theoretical work "Investigation of Outer Space by Reaction-Powered Instruments," which he had prepared for several years. This was the first scientific work which contained analytic part and constructive proposals about a drop-shaped form of body of rocket and its structure and control. But soon after its release the journal was closed down by the police. The article of Tsiolkovskiy (only its beginning was published) remained unnoticed, particularly because it was released without the author's proofreading and contained confused formulas and other defects, hindering its comprehensibility. Only in 1911 its continuation appeared in an aviation journal, "Herald of Aeronautics," released in Petersburg. Then in Russia the airplane industry had already begun, there were created the first aviation and aeronautical enterprises. In these conditions there was published an article by Tsiolkovskiy dedicated to his creation, on absolutely

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*Ibid, p. 49 - 50.

**As it is known, on third Soviet satellite, starting its flights in space on 15 May 1958, there were used solar batteries feeding its radio equipment. Solar batteries were installed also on American satellites -- "Explorer I" and "Explorer III."

new branch of science — astronautics; this produced a great impression. There appeared followers, whose number increased rapidly not only in Russia, but also abroad, just as inventors of reaction-powered aircraft.

Tsiolkovskiy continued to experience a great need, obtaining no help for his scientific investigations. In 1916 he obtained a proposal from the editorial office of the widely circulated journal "Nature and People" to complete the science-fiction narrative "Beyond the Earth." But when only half of the manuscript had been printed, the journal went out of publication and his manuscript product was returned to Tsiolkovskiy in Kaluga. Only under the Soviet regime, in spite of great difficulties with paper, did friends of Tsiolkovskiy and the Kaluga regional society manage to have printed in 1920 three hundred copies of this book.* Although circulation of the edition was small, the book obtained fame even beyond the borders of our country.

In Germany in 1923 there was published the work of professor H. Oberth "Rocket in Outer Space." Becoming acquainted with it, Tsiolkovskiy wrote:

"In Oberth's work there is much similarity with my "Beyond the Earth:" pressure suits, staged rockets, tying people and objects to a chain, black sky, nonglimmering stars, mirrors (in outer space), light signalling, base beyond the Earth, travelling further from it, passing around the Moon; even the mass of rocket lifting the people, 300 tons; the study of the Moon and many other things.**

Professor Hermann Oberth in 1929 in his congratulations to Tsiolkovskiy on his birthday, very definitely speaks of the undisputable priority of the Soviet scientist: "You lighted this fire, and we will not let it die out; we will endeavor to carry out the greatest dream of humanity."***

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*K. E. Tsiolkovskiy. Beyond the Earth. Publication of Society of Study of Nature and Local Region. Kaluga, 1920 (p. 1).

**Ya. I. Perel'man. Tsiolkovskiy. M., 1937, p. 58.

***Archives of Academy of Sciences of USSR, F. 555, op. 4, No. 288.

The tale "Beyond the Earth" is one of the brightest science-fiction products, brightly characterizing the creative work of K. E. Tsiolkovskiy in this area. The main actors of this book are six scientists of different nationalities, united to carry out scientific investigations in a specially built castle in the Himalaya Mountains. At their disposal are many engineers, masters, highly skilled workers, and the necessary equipment.

Tsiolkovskiy symbolically named his heroes after great scientists of the past of different countries — the Italian is Galileo, the Englishman Newton, German Helmholtz, the Frenchman Laplace, the American Franklin, and the Russian is Ivanov. This is not simply a literary device method, but is the reflection of the deep thought which permeates the whole manuscript: the conquest of outer space by humanity can be accomplished most efficiently and expediently only collectively, and not separately, by forces of some one country, i.e., as now the Soviet Union proposes, having undisputable superiority in the study and mastering of Space.

In Tsiolkovskiy's collective sketch "Beyond the Earth" the modest Russian scientist Ivanov becomes the leader of the enterprise, which from the beginning seems fantastic to the others. But soon with enthusiasm they attend to its realization. Ivanov proposes no more nor less than the construction of a rocket - a reaction-powered spaceship, whose basic principles of construction and power circuits Tsiolkovskiy, as already mentioned above, gave in 1883 in the monograph "Free Space." Here he definitely calls his spaceship a rocket. In the book "Beyond the Earth" the tone of the author is no longer that of "Dreams about Earth and Sky:" careful, at times remotely hypothetical. Now he speaks in full voice about his aspirations, as well as about the means of their realization. With sure strokes he sketches an inspired work of a friendly collective of scientists and in most detailed manner tells about the layout of the first spaceship — a rocket; and then also its subsequent construction. Before the reader there are unfolded, one after another, pictures — the dreams of a scientist. The first circling the Earth. Travellers communicate with comrades remaining in the castle by means of mirror light

signalling, i.e., by that method which Tsiolkovskiy described in 1896 in the newspaper "Kaluga Herald." The population of Earth will learn that outer space is already open to people. There are declared the first ones wishing to make the migration to other planets. Preparation toward this is being made. In the meantime the untiring Ivanov, with one of engineers, prepares and then carries out the visit to the Moon; they travel on its surface on special tankette and observe lunar animals...

In a word, Tsiolkovskiy depicted here, as he imagined it, the forthcoming mastering of space by humanity.

In subsequent years, when the scientific creative work of Tsiolkovskiy attracted the attention and support of the Soviet public and government, he still more specifically and deeply developed these ideas in the work "Purpose of Stellar Navigation," published in 1929. It is written in that same science-fiction genre and attracts one first of all by how thoughtfully and to the smallest details the huge and complicated work which awaits humanity in the future centuries and millenium in Space is described.

Important questions of "biology of future," inevitably connected with evolution of living creatures in the process of the "conquest of solar space," are represented in our collection by two works by Tsiolkovskiy: "Living Creatures in Space" and "Biology of Dwarfs and Giants." In the first, he treats in his own way the question of causes and ways of propagation of life in Space. This small work contains, in the fantasy form of expression of Tsiolkovskiy, the vital processes including the fact that humanity, appearing in space vacuum, will be forced to alter its physical structure.

The work "Biology of Dwarfs and Giants" is extracted by him and is prepared for press the great manuscript "Mechanics in Biology" (1920 - 1921), which remained unprepared for publication. This subject he began to develop in 1882, and the first part of the manuscript was dispatched for an opinion to the great Russian scientist-physiologist I. M. Sechenov. In spite of the fact that the work was still not

completed by the author, Sechenov took to it with interest and counseled Tsiolkovskiy to complete it. But only after 40 years was it completed.

The collection ends with articles "Beyond the Atmosphere of Earth" and "Ether Island." The first of them starts with Tsiolkovskiy's remarks about experiments with automobiles and sleighs provided with rocket motors, around which there arose a groundless uproar in Germany in 1928 - 1929. The article tells of a number of original and interesting situations about reactive technology. The article "Ether Island" is written very uniquely on astronomical subject. In an old house in Kaluga, on a street named after Tsiolkovskiy, where now his museum stands, on one of the walls of the glazed verandah on the second floor, serving the scientist as an experimental workshop, there is a door. It leads to slightly sloping roof of a shed adjoining the house. The family called it the "door to outer space." On good, quiet evenings with cloudless sky the scientist carried through this door on roof a tripod with a small amateur telescope and together with his wife, Barbara Yevgrafovna, or with any of the frequently visiting neighbor children, he observed the stars. Here at once started a wonderful, captivating story about constellations, planets, nebulae, and shooting stars. And the article "Ether Island," published for the first time, in which there is excellently described our galaxy, on its content and by form the account reminds one considerably of just such a sincere, intelligible scientific conversation conducted by the scientist among his close friends.

As an Appendix to the collection there is the article of Tsiolkovskiy "Inventors of Reaction Instruments," in which he thoroughly, accompanying by figures, explains the construction of models of reaction jet aircraft, which one can build himself without any kind of complicated tools and special materials. It is necessary to say that Konstantin Eduardovich watched very attentively how children occupy themselves in regard to manual labor and modeling at the local children's technical station. Wishing to answer numerous questions, such as which models should he

recommend to modelers and how to prepare them so that working with them would be absolutely safe, K. E. Tsiolkovskiy wrote the article, which is published for the first time in our collection.

A tireless fighter for the progress of humanity and its culture, whose basic slogan of life was the effort "to advance humanity forward at least somewhat," Tsiolkovskiy by his inspiring works awakened human thought. Acquaintance with them at present, when we entered the epoch of mastering of Space, presents great cognitive interest.

K. E. Tsiolkovskiy labored for seventeen years under the Soviet regime. His works called for a broad movement for mastering of the stratosphere and investigation of outer space and the number of pupils and his followers increased rapidly. After Tsiolkovskiy himself ceased investigations in his experimental workshop, his followers — Engineers V. P. Glushko and F. A. Tsander presented first designs of Soviet jet [reaction] engines, working on liquid fuel. Into air were launched the first Soviet liquid-fuel rockets. Tests of experimental designs of jet aircraft were conducted. Tsiolkovskiy in these years concentrated all his energy on the creation of extensive work on jet engines.

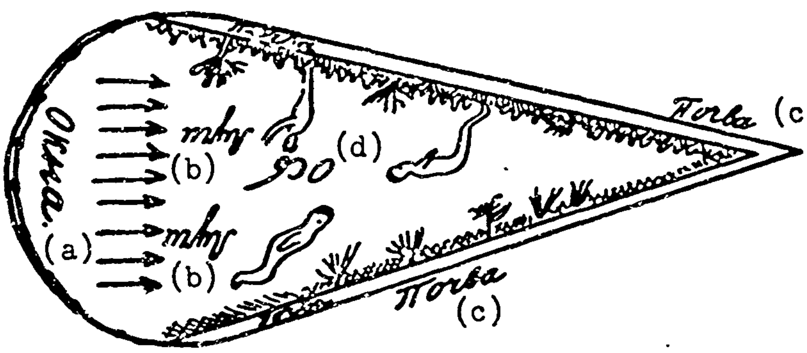
His brilliant ideas, indicating ways and methods of penetration of man into space, with each day more distinctly discovered majestic opportunities for development of this great undertaking. But ill health more and more frequently hindered the work of the scientist.

In "Pravda" 14 September 1935 there appeared the text of document, entering the history of science, — letters of Tsiolkovskiy in the Central Committee of the Communist Party of the Soviet Union, in which he wrote:

"...All my life I dreamt to at least somewhat advance humanity forward by my writings."

...All my works on aviation, rocket navigation, and interplanetary communications I transmit to the Party of Bolsheviks and to the Soviet Government — authentic leaders of progress of human culture. I am sure that they will successfully complete these labors.

ее можно регулировать при жилищах удлиненных вдоль лучей солнца: чем он длиннее, тем температура будет ниже.
54. Почва сбивается от вращения дальше от оси так, что лучи скользят вдоль ее поверхности и засаженных на ней растений. На дне же шара почвы не удержится растений там не будет и сила солнца будет пропадать даром. Однако при длинных конусах, наклон поверхности и почвы будет не велик, она останется на месте и растения будут освещены косыми лучами до самой оси. Достигнем и умеренной температуры и использования солнечных лучей



From K. E. Tsiolkovskiy's "Album of Space Journeys" (1933). Explanatory notes for the diagram of dwelling (greenhouse) in Space.
KEY: (a) Windows; (b) Rays; (c) Soil; (d) Axis.

With my whole soul and thoughts I am Yours, with my last sincere regards always Yours

K. Tsiolkovskiy"

19 September 1935 the great Russian scientist Konstantin Eduardovich was no more.

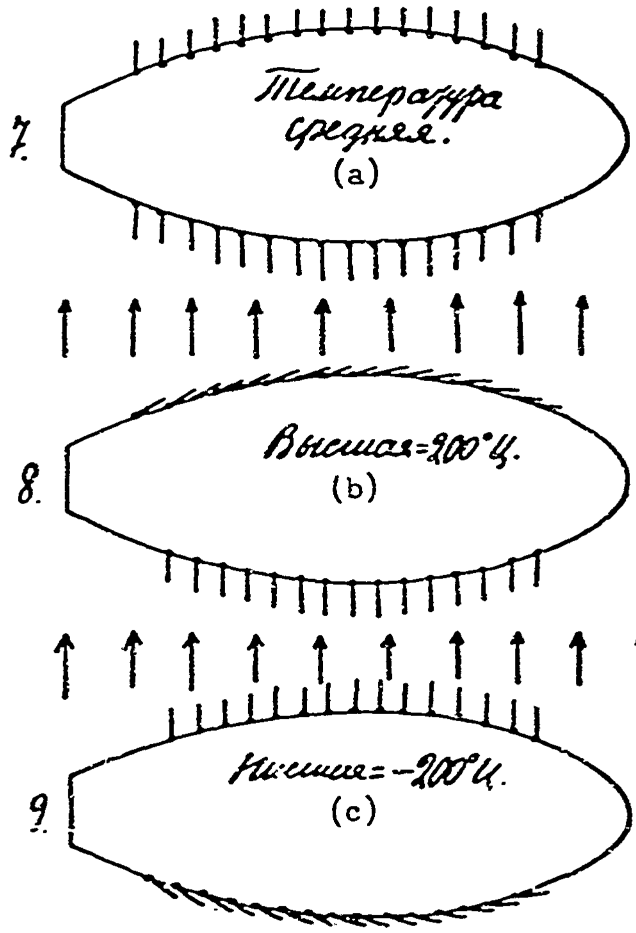
The honorable relay race on realization and implemeting into life the ideas of Tsiolkovskiy on rocket navigation and interplanetary communications was taken up by his pupils and followers — Soviet scientists, engineers, production workers, workers.

Now to all the world are known the achievements of the Soviet Union in the region of penetration into Space and its mastery, which opened a new epoch in the history of mankind.

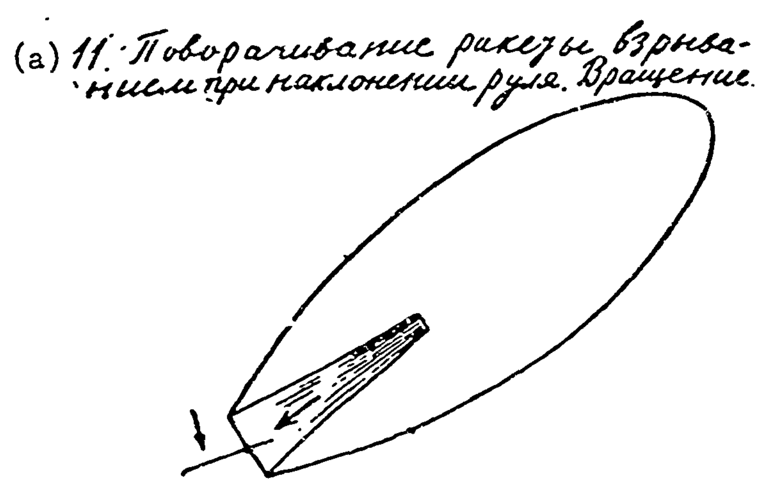
Several days after the Academy of Sciences of USSR and other scientific establishments and public organizations noted the 100th anniversary since the birth of K. E. Tsiolkovskiy, on 17 September 1957 a monument was erected to him on Leningrad prospect in Moscow and embodied in Kaluga on Peace Square. On 4 October 1957 was launched the Soviet artificial earth satellite, the first in the world. This event produced in the whole world a huge impression. Soon, 3 November of the same year, in the Soviet Union there was successfully launched a second artificial earth satellite weighing 508.3 kg, with a pressurized cabin in which there was an experimental animal — the dog Layka.

On 15 May 1958 there was launched into orbit the third Soviet artificial earth satellite, of still larger weight — 1327 kg, including weight of equipment for scientific investigations, radio transmitters, and power sources.

On 2 January 1959 in Soviet Union there was launched a space rocket, which for the first time attained second space speed [escape velocity] — 11.2 km. per second; it passed at a distance of 5,000 km. from the surface of the Moon and became a



From K. E. Tsiolkovskiy's manuscript "Album of Space Journeys" (1933). Sketch illustrates action of louver on spaceship, which regulates the temperature inside it. Arrows show the direction of rays of Sun.
KEY: (a) Average temperature· (b) Highest = + 200° C.; (c) Lowest = -200° C.



From K. E. Tsiolkovskiy's manuscript "Album of Space Journeys" (1933). Sketch explains action of jet vanes on reaction-powered spaceship.
KEY: (a) 11. Turning of rocket by detonation during inclination of steering wheel. Rotation.

satellite of the Sun. Thus there appeared the first artificial planet in the solar system. The weight of the last stage (without fuel) was 1472 kilograms.

On 12 September 1959 there was launched a second Soviet space rocket to the Moon, which reached it in 1.5 days, delivering to its surface the Soviet message with the state emblem of the Soviet Union. The last stage of the rocket, whose weight without fuel was 1553 kg, and the Soviet State messages were the first articles made by the hands of man delivered to another planet in history of humanity. On 4 October 1959, the second anniversary since launching of first artificial Soviet earth satellite, the third Soviet space rocket was launched in direction of the Moon. Its last stage carried an automatic interplanetary station, which with the help of a special system of orientation and special arrangement of photographic equipment, (being controlled by radio) for the first time produced photographs of the reverse side of Moon, invisible from Earth, and then transmitted the obtained images to Earth by radio. The automatic space station was a complicated and perfect piece of equipment, which allowed our scientists, engineers, and workers to execute this truly unprecedented scientific feat. Each launching of artificial earth satellites and space rockets constituted a new further, higher stage of the beginning of conditioning of humanity to Space: "It is obvious that the investigations performed are only the beginning. Ahead are remarkable prospects of further space flights," — stated Academician L. I. Sedov, Chairman of International Federation of Astronauts [Astronautics] on November 1959.

When after conservative and clear descriptions in reports of TASS of details of the structure of the automatic interplanetary station of third space rocket, one reads science-fiction products of Tsiolkovskiy, one involuntarily stops on already familiar names. For instance, one meets the term "gyroscopic transducer" in the monograph "Free Space," describing the first design of a spaceship in 1883 (see figure in appendix.). Solar batteries, named solar motors, are described in "Dreams about Earth and Sky" (1895). Adjustment of internal temperature by means of louver

is shown on the sketch of Tsiolkovskiy's manuscript "Cosmic Journeys" (1934).*
Light signalling repeatedly is repeated on pages of tale "Beyond the Earth" (1920), only not with help of sodium vapor, as during flight of Soviet space rockets, but bright electrical searchlights.

It is obvious that during the design, in contemporary conditions, the production, and the launching by Soviet scientists and engineers of artificial earth satellites and space rockets there were done and carried out immeasurably large quantity of projects and inventions. But we wanted to indicate those ways by which were developed and implemented in life those 'dreams' of the brilliant founder of the theory of rocket propulsion and interplanetary communications, which brought our Motherland huge achievements and unfading glory down the centuries, confirming the whole force and accuracy of determination of V. I. Lenin — "Fantasy is a Quality of the Greatest Value."**

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*K. Tsiolkovskiy. Space Journeys (incomplete manuscript). Archives of Academy of Sciences of USSR, F. 555, op. 1.

**V. I. Lenin. Compositions, V. 33, p. 284.

APPENDICES

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APPENDIX I

TO THE INVENTORS OF REACTION-POWERED MACHINES
(28 April 1930)

I receive from adults and children hundreds of projects of reactive means of movement. To all of them I can answer as follows.

Essence of motor of direct action consists in that, that one matter is rejected to the right, and missile from the strength of recoil moves to the left. So that reserve of explosive would be least and did not burden the vehicle, it is necessary, that the speed of rejected reserve matter be the greatest [possible], since speed of ejected material corresponds to speed of vehicle. Explosives or fuel, being connected with reserve oxygen compound, give a speed of gaseous ejected material of 1,000 to 5,000 m per second. And they have to be usable.

When the explosion occurs, then one part of its energy is transmitted to the instrument, and the other goes for fast motion of ejected gaseous material. In order for a decent use of chemical energy to occur, it is necessary that the speed of missile would not differ much from the speed of the outgoing gases. Let us assume this second speed of gas stream to be 2,000 m. Then for high utilization of explosive or elements, forming the explosion, there is required for vehicle a speed close to two kilometers per second. One kilometer would probably be sufficient.

But can there be such speeds on our roads and in air?

With the speed of 1,000 m/second the pressure of head on flow per square meter of area will be more than 100 tons. In reality the condition of motion is still worse.

Actually, with speed, greater than speed of sound, air is condensed ahead of a surface and presents an insuperable barrier (like a hard wall). Furthermore, all wheels from such speed would burst into pieces, and roads become impossible: with small speed their unevenness is tolerable, but with great speeds it is unbearable.

And if in air resistance is insurmountable, then in water it is still more. Consequently, also hydroplanes would not rescue us.

How will it be? Could it be that jet engines of direct action are not applicable to anything?

We do not say this. Grief can be helped, if one were to give the carriage a prolongated even form of a bird or fish, and to move not over solid or liquid roads, but on air.

Thus, we involuntarily arrive at the thought about a reaction-powered, fast-moving airplane. But the last one also, no matter how excellent its form, in lower tight layers of air cannot obtain speeds of several kilometers per second. We have to transfer arena of action for our airplane into the rarefied layers of atmosphere, into the stratosphere.

Our reactive airplane, or rocket aircraft, is turned into a rocket stratoplane. The problem is complicated and back-breaking for children's knowledge, powers, and erudition. For this there are specially conducted studies in research institute of jet propulsion. We will give it this work and possible achievements.

What can we do for children? We can make very interesting children's toys. Unfortunately, they all were already made and even patented, supposedly serious inventions. For us there remains only to repeat them. However, they are instructive for adults and children.

We will enumerate them.

1. Boat with guns. A spring gun or a gas or powder type ejects a shell, and the vessel for a certain time moves in the opposite direction.

2. Boat with horizontal fountain. On little vessel there stands a cylinder

with water. It is located on the stern. Water from it pours out through a lower hole outside, into basin. Recoil forces the boat to move (until all water flows out from the cylinder).

3. Steamer. On the boat there is placed an iron pot, heated by alcohol. The water boils, turns into steam and bursts through a very narrow hole in the stern part of the steamer. The latter is set in motion. Action will be much stronger, if by means of tube the steam could be directed under the water. But this will no longer be pure type of reactive machine.

4. The same type of reactive automobile. But here for better results instead of a pot there should be a little, ordinary rocket. The force of steam in ordinary conditions will be insufficient to move the carriage.

5. Gas boat. Instead of heated pot with water it is possible to have an inflated rubber balloon. The air bursting from its apperature will force the boat to move. One can use the rubber sphere from a soccer ball.

6. All are familiar with the flying sausage made of inflated rubber.

7. Ordinary rocket, supplied, for the sake of effect with a chamber with toy travellers.

8. Airplane without propeller, but with rocket. It is advisable for the sake of correct flight to make a long light tail (it would be good out of calico) in its stern area.

Besides amusement, these toys can serve as transition steps to construction of jet stratoplanes.

APPENDIX II

IS IT ONLY A FANTASY?

I was approached approximately 10 years ago with a request to stage on the screen my story "Beyond the Earth." But the matter was so complicated that the enterprise was postponed. And here, only now, Mosfilm with talented V. N. Zhuravlev resolved definitely to create the picture "Space Voyage."

I started to dream about the possibility of travelling beyond out planet already at 17 years of age. In 1895 I wrote the book "Dreams about Earth and Sky." It was published by the nephew of the famous Goncharev, then was republished twice by the State under the heading of "Gravity Disappeared." In the first years of the revolution I pursued this subject seriously. Reflection of these works was the fantastic tale "Beyond the Earth" (1918).

The mathematically developed theory of the reactive device appeared already in 1903 at first in a poorly circulated philosophical journal of Filippov, "Scientific Review," and after several years in "Herald of Aeronautics" (1911 - 1913). Then there appeared several printed works in separate publications and in journals. After 1913 my works also became known abroad.

Nothing interests me as much as the problem of victory over terrestrial gravity and space flights. It seems that half of my time, half of my strength I devote to the development of this question. Here I am already 78 years old, and I am still continuing to calculate and invent concerning the reactive machine. How much I have thought over, what thoughts have passed through my brain! These already were

not fantasies, but factual knowledge, founded on the laws of nature; there are prepared new discoveries and new compositions. But fantasy also attracted me. Many times I undertook to write on the subject "Space Voyages," but would end up by being attracted to the exact considerations and would pass on to serious work.

Fantasy stories on the subject of interplanetary trips bring new thoughts to the masses. He who is occupied with this is engaged in a useful matter: he evokes interest, stimulates mental activity, gives rise to sympathetic and future workers of great intentions.

What could surpass the total mastering of the Sun's energy which is 2 billion times greater than that which falls on Earth! What could be more excellent than to find a way out of the narrow corner of our planet, to become accustomed to universal free space and to give people an outlet from terrestrial limitations and the weight of gravity?!

Greater than literature is the influence of films. They are more graphic and closer to nature than description. This is the highest step of artistry, especially since movies have mastered sound. I consider it a great act of heroism that Mosfilm and comrade Zhuravlev undertook to film "Space Voyage." And it is impossible not to express great satisfaction from this work.

How do I myself look upon space voyages; do I believe in them? Will they be sometime accessible to man?

The more I worked the more various difficulties and obstacles I encountered. Until recently I assumed that hundreds of years would be needed for the realization of flights with astronomical [escape] velocities (8 - 17 km, per second). This was confirmed by those weak results which were obtained by us and abroad. But continuous work recently swayed my pessimistic views: methods have been found which will give amazing results even in a decade .

The attention which our Soviet Government allots to the development of industry in USSR and any kind to scientific investigations will, I trust, justify and affirm these my hopes.

(Journal. "Komsomolskaya Pravda," 23 July 1935).

town - Kaluga.

APPENDIX III

PAGES FROM NOTEBOOK FROM YOUTH

In 1878 - 79, living in Ryazan', K. E. Tsiolkovskiy developed questions of interplanetary communications. In its archives in the Academy of Sciences of USSR there is saved (pertaining to that time) a small, school-size notebook with 13 pages. In connection with this work he at the same time produced experiments with the help of home-made instruments — mainly with a rotating machine.

Using experimental mice, chicks, and also insects, K. E. Tsiolkovskiy was determining what action the acceleration due to gravity renders on living organisms. In this notebook, from youthful years, the future scientist writes down considerations about desirability of arranging other experiments and investigations, making sketches and diagrams of new instruments for this purpose.

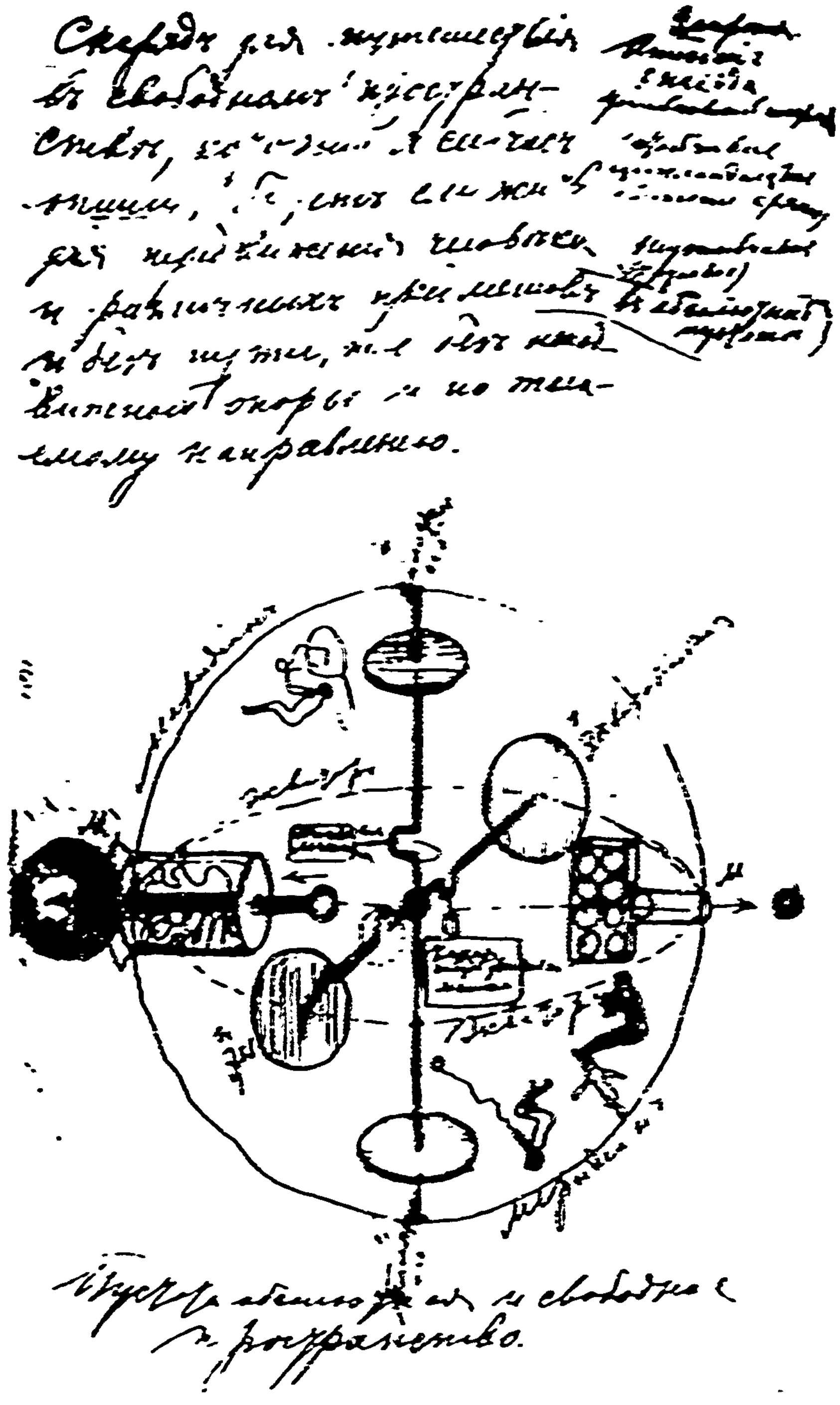
Recordings in this notebook were rough notes of the monograph "Free Space," which he wrote while living in the city of Borovsk, where he worked from 1880 as teacher of arithmetic and geometry in a primary school.*

In the collection of several pages of the notebook printed here are imprinted the ideas of Tsiolkovskiy which he, in a strictly scientific and at the same time captivating form, developed subsequently in his compositions.

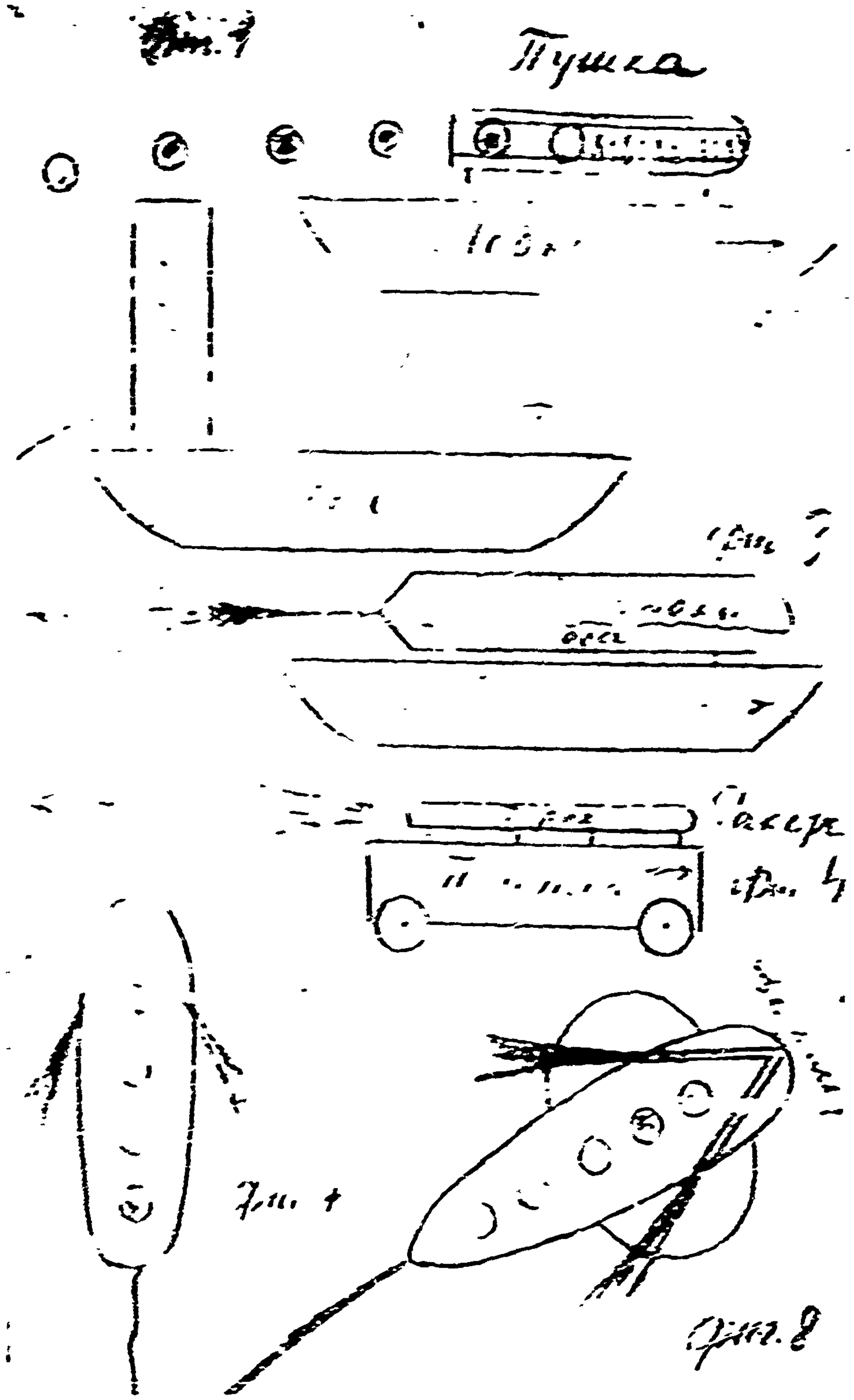
Editorial Office

*Work "Free Space" for the first time is printed in Volume II of the collection of compositions of K. E. Tsiolkovskiy Publishing House of Academy of Science in 1954. (p. 25 - 68). — Edit.

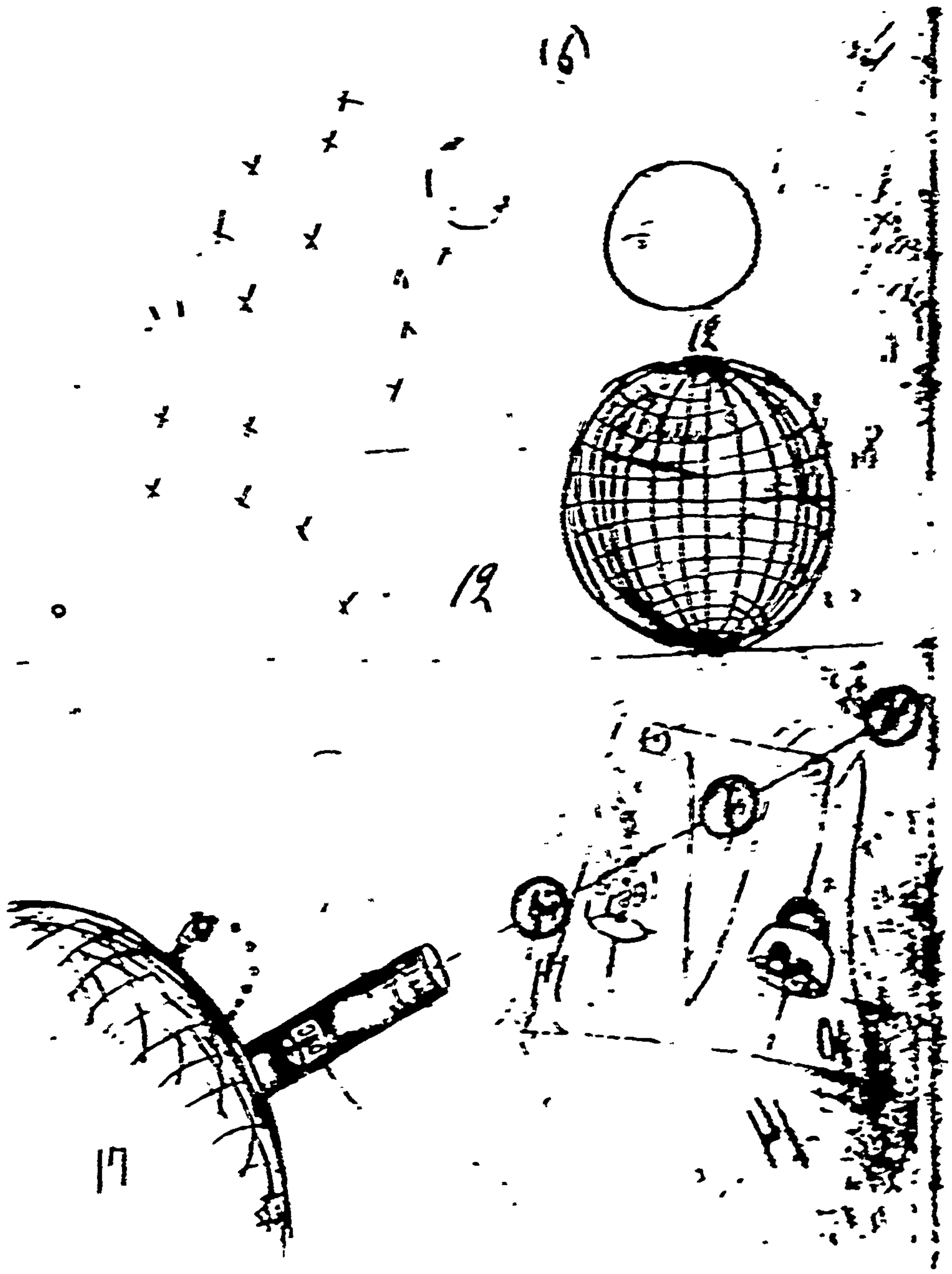
To page 449(Original document).



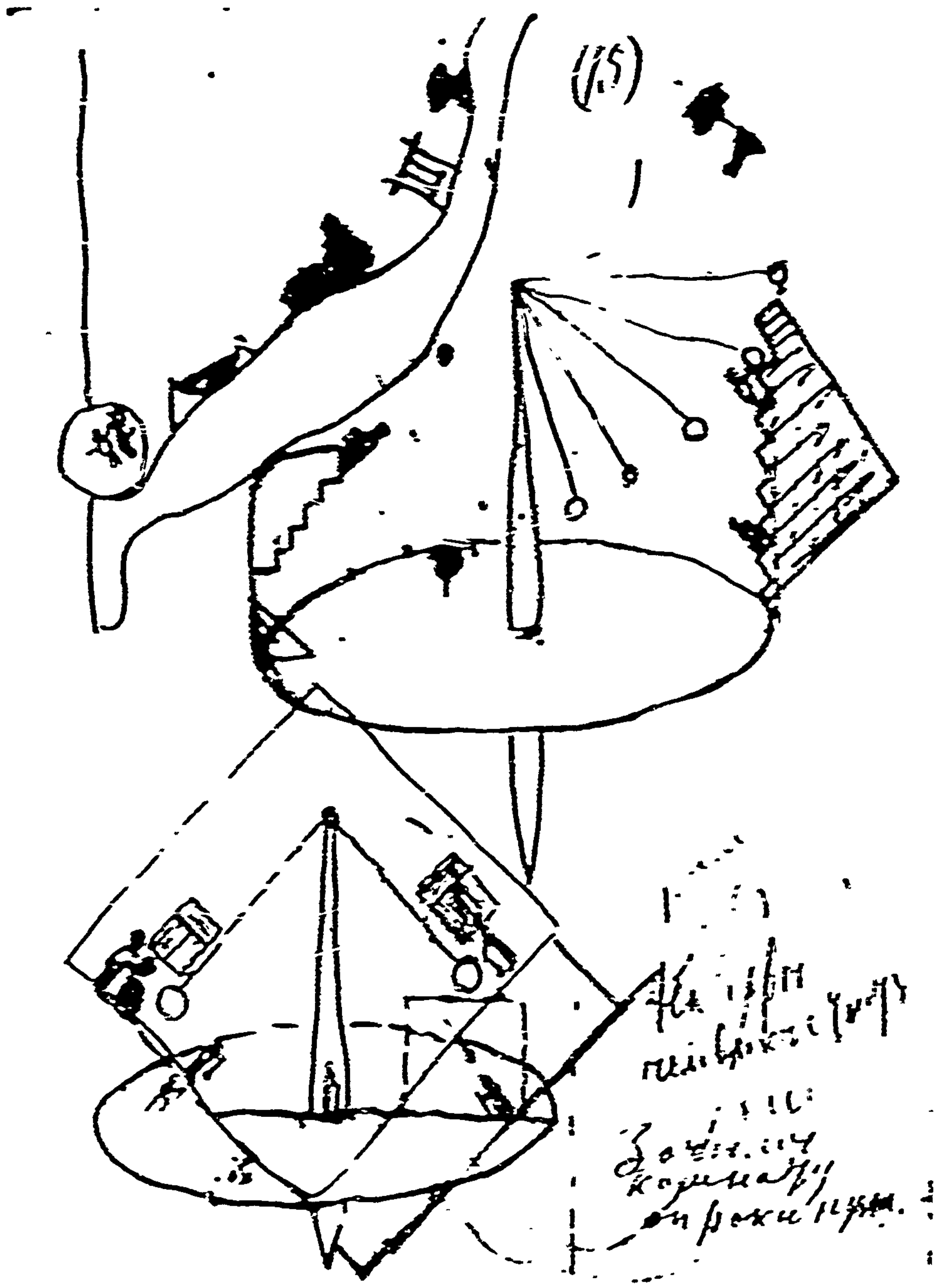
Facsimile of manuscript of K. E. Tsiolkovskiy, "Free Space" (1883). Sketch (section) of reactive spaceship. On the right — a cannon, shooting with round shot; its recoil (reaction) is communicated to the ship a motion in space. In middle — gyroscopes, by whose rotation the position of (orientation) ship in space can be changed. Sketch is dated 9 March 1883 (old calendar).



Personal sketch of K. E. Tsiolkovskiy in article "To the Inventors of Reaction-Powered [Jet] Machines."

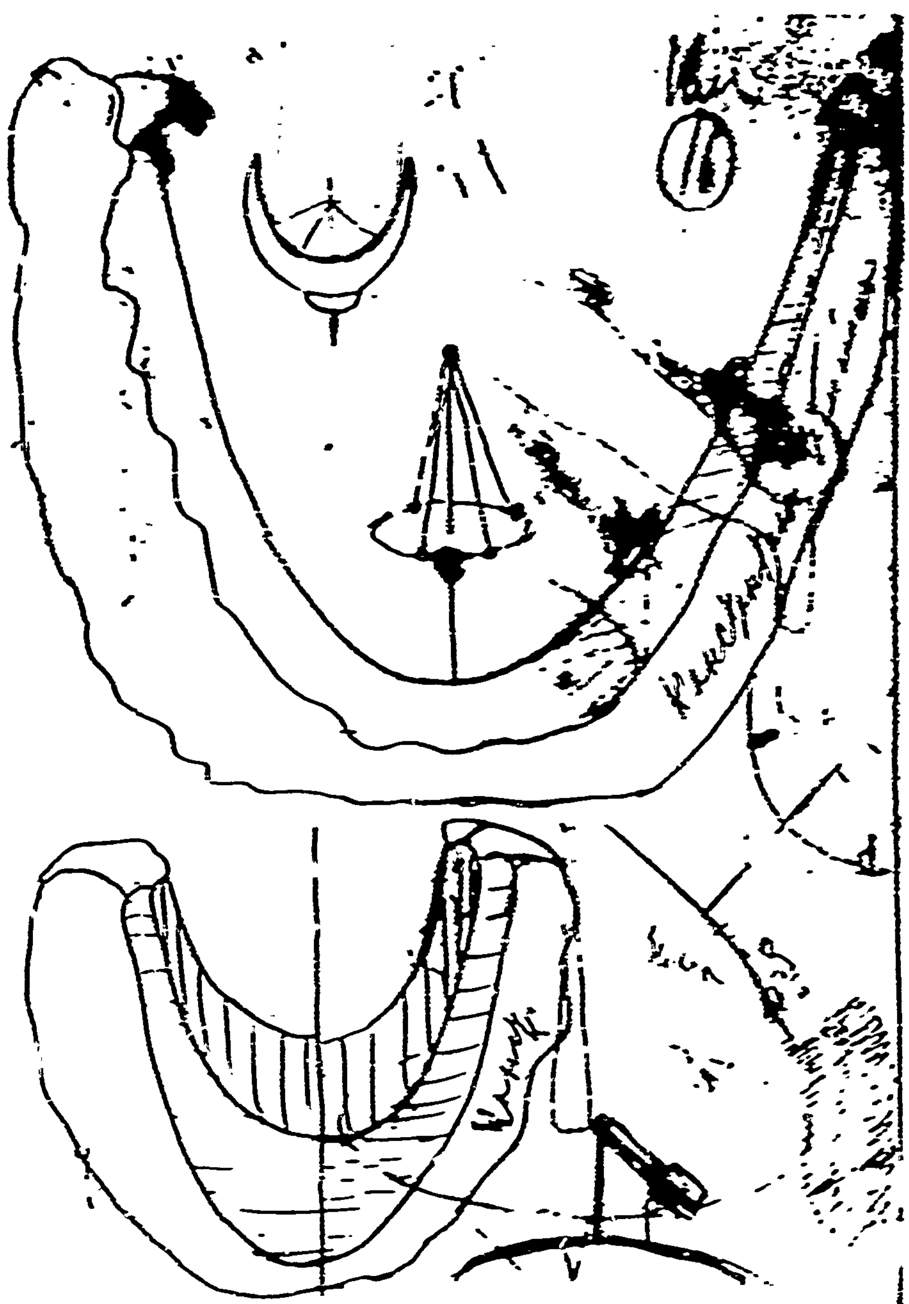


In a thrown or falling cannon ball there is no gravity. In a railroad car starting or finishing its motion, there is initiated horizontal gravity, which forming with terrestrial gravity, gives a slanted relative gravity. The same is true in a shot from a horizontal cannon.

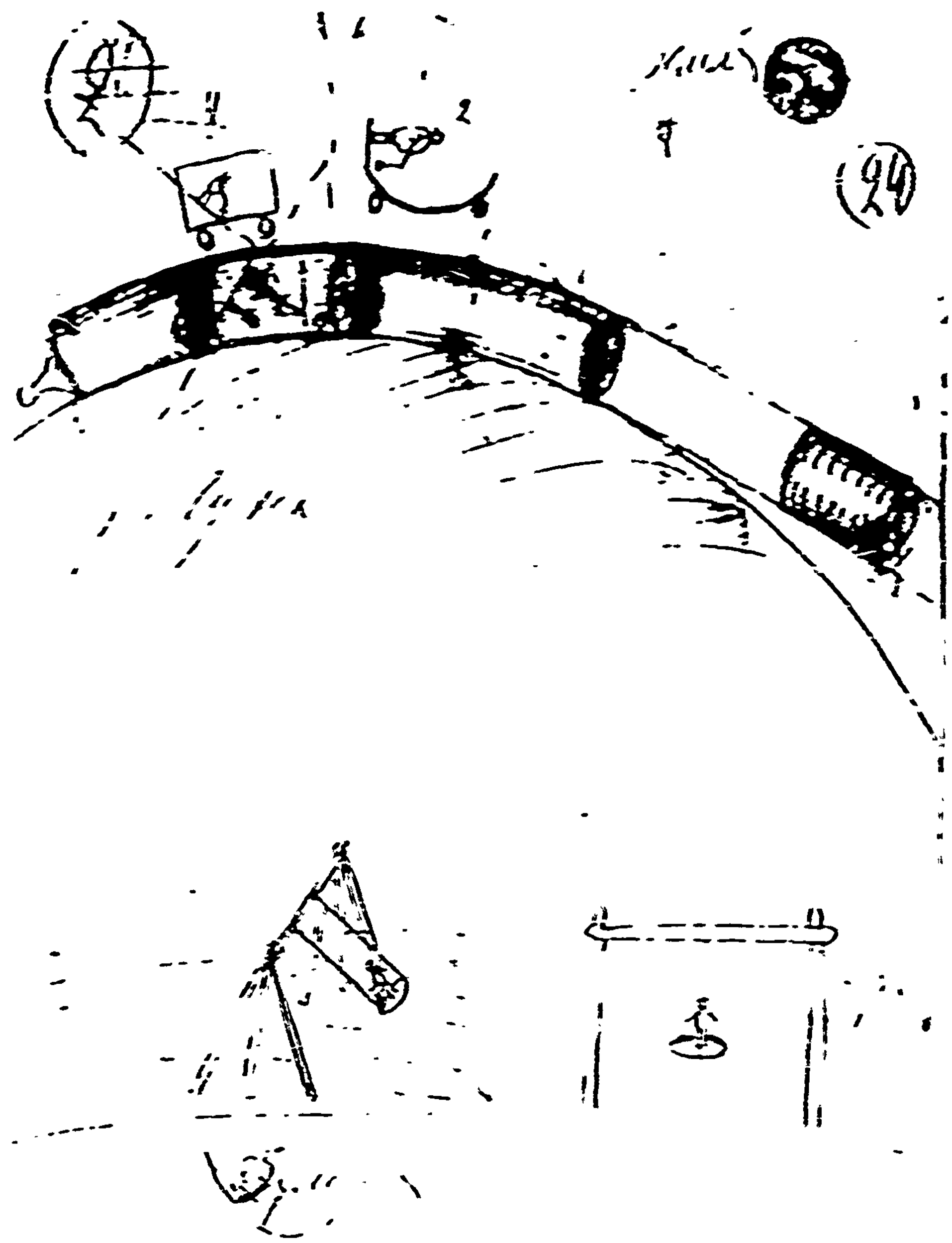


In the room there are two men standing perpendicularly to one another.

To Appendix III

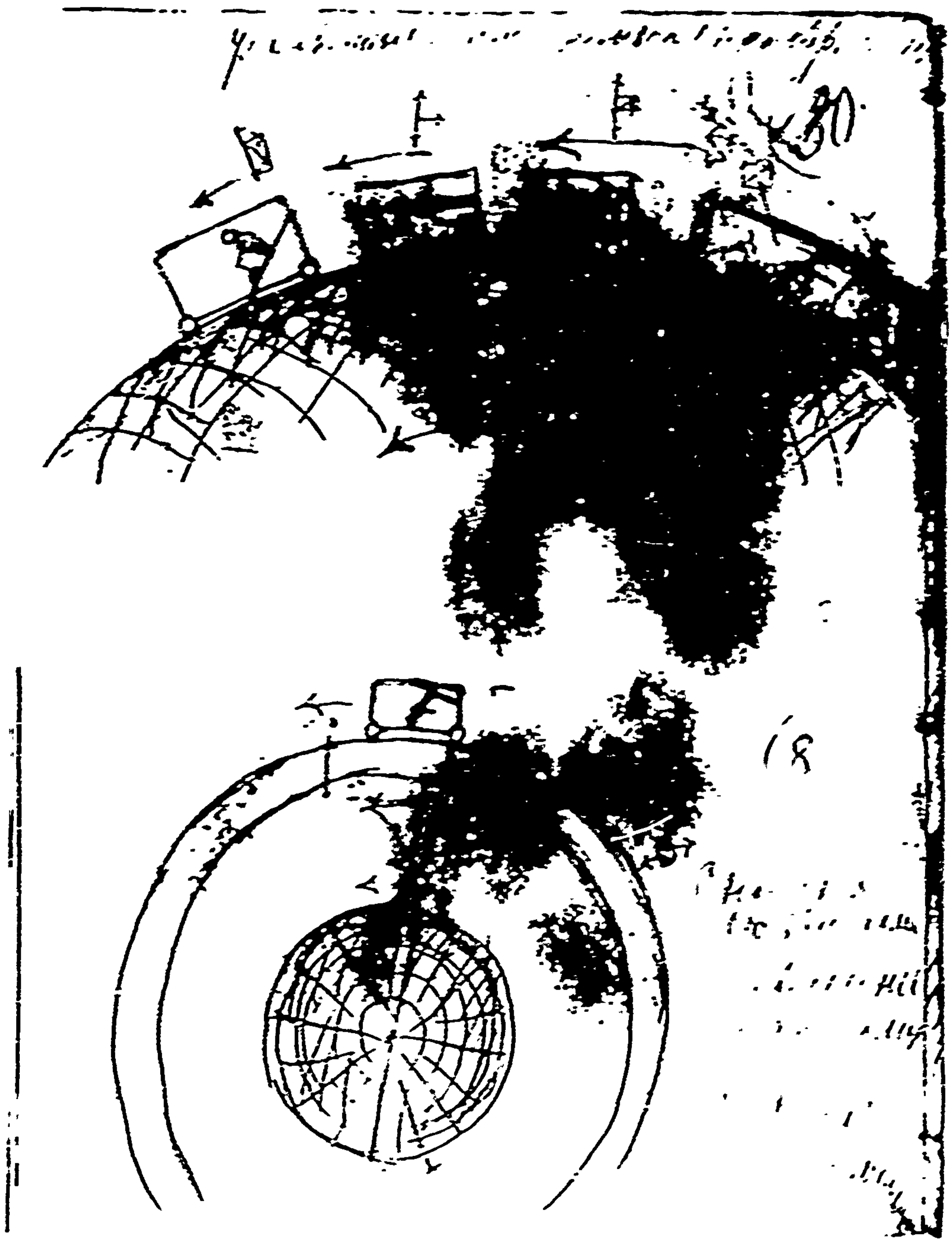


Liquid takes a shape (body) of revolution.



Phenomena in cannon ball of arched
[elevated] cannon and on a swing.

To Appendix III



In space free from gravity curvilinear motion produces relative gravity proportionate to curvature of the arc and the square of the speed of railroad car.

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ABSTRACT: This article is a collection of science fiction works and a number of propositions by the Russian author, K. E. Tsiolkovsky. Many of his ideas and propositions have proven to be innacurate, but nevertheless he did accurately describe some possibilities of the space environment as we know it today. He proposed that the absence of gravity facilitates work, and this relieves the pain of the aged and the ill. He proposed the use of a special green house for supplying food and the restoration of wastes into usable air and water. All necessary energy was to be obtained by mirrors from the sun's rays, which Tsiolkovsky thought were being wasted for the most part.

He gives an adequately accurate description of the moon's landscape, but he is prosupposing too much in the description of native life on the moon and other planets, especially without an atmosphere, and the ease with which gravity is defied. Tsiolkovsky also underestimated some suppositions about the acceleration force in the absence of gravity and the danger of meteorite collision. He overestimated the possibility of using a liquid medium for reducing "g" forces on man during acceleration and the possibility of "cataching" meteorites with nets as one would catch butterflies. Some other improbable conceptions of his are the underestimation of using mirrors to create temperature increases at great distances from the sun, the assumption that all starts have planetary systems, migrations to other planets is a necessity, the estimation of the sun's "cooling" and destroying the Earth, forcing humanity to find another home by migration to other planets. Despite his innaccurate assumptions, his articles are of value.